The Gardens' Bulletin

STRAITS SETTLEMENTS

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Summit of Gunong Belumut, with shoulder-high scrub containing Matonia.

PLATE I.

THE

GARDENS' BULLETIN,

STRAITS SETTLEMENTS.

Vol. III November 7th, 1924. Nos. 7—8.

THE VEGETATION OF GUNONG BELUMUT IN JOHORE.

The present paper is an attempt to describe the vegetation on the upper part of Gunong Belumut, a mountain situated in the south of the Malay Peninsula, about the middle of the State of Johore. The summit is 3,321 feet above sea level, and the area here dealt with is that lying between an altitude of about 2,800 feet and the summit. The writer visited this locality in May 1923, in company with Mr. G. R. Fulton, Assistant Government Geologist, to whom he wishes to express his very cordial thanks for the opportunity of making the expedition.

The route followed was that made by Mr. J. G. Watson, Conservator of Forests, Johore, who had ascended the mountain a short time previously. Except a few plants obtained by Mr. Watson, no collections had been made on the mountain. The jungle track starts from about the 14th mile on the Kluang-Mersing road. From this point to the Sungei Berhidong at the foot of G. Belumut is about 11 or 12 miles, the track crossing the ridge of G. Chemundong at a height of 1,265 feet. From the camp by S. Berhidong, at 450 ft. above sea, to the summit of the mountain is about three miles.

The lower part of the ascent is through rather dry Dipterocarp forest, with Bertam (*Eugeissonia*) as the chief undergrowth. At about 2,500 ft. a transition begins to occur to a forest of crowded trees of much lower stature, gradually more and more covered with liverworts and mosses. Within about 300 ft. the change is complete from a fairly high forest to the mossy elfin forest which

covers most of the area between 2,800 ft. and the summit. On the northern slope however the mossy forest is replaced by an open scrub in which for the most part *Matonia pectinata* is dominant, with stunted shrubs and trees growing above it at intervals (Plate I). The transition from the forest to the scrub is very sharp near the summit, but less so at lower altitudes. The name Belumut is descriptive of the mossy condition of the summit.

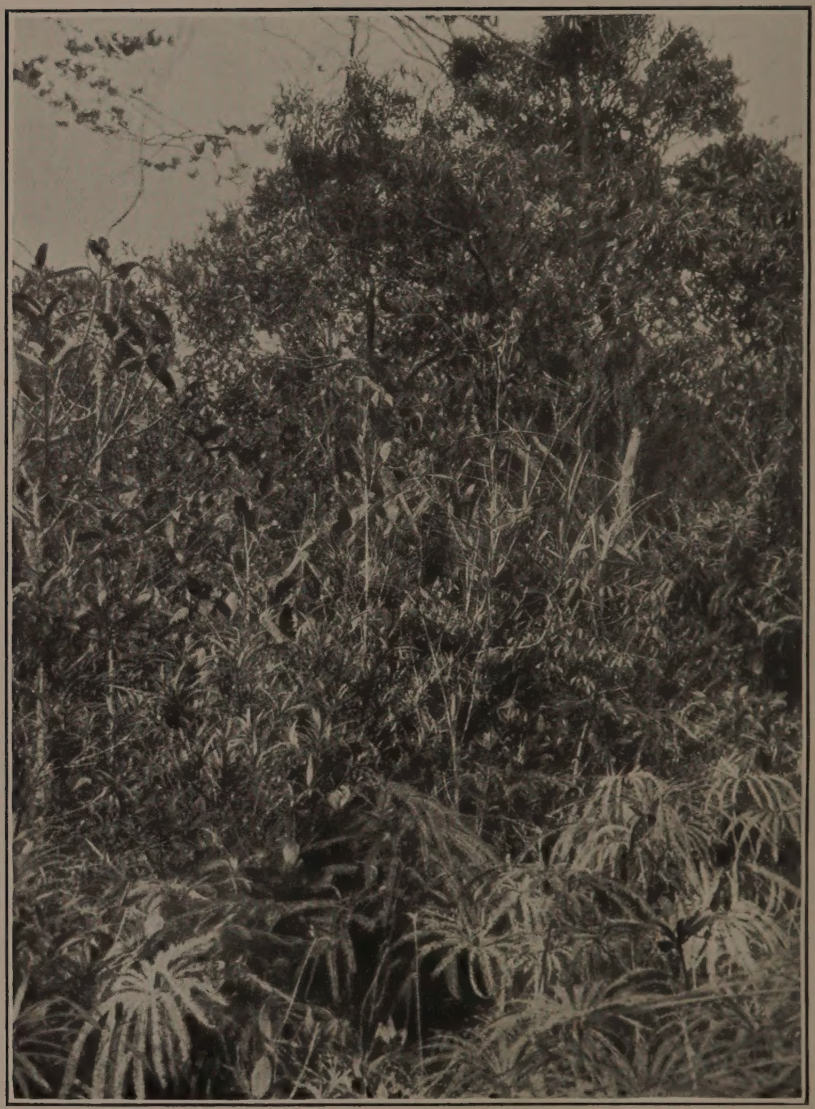
A camp was made on the summit of the mountain, and seven days spent there. As complete a collection as possible was made both of flowering plants and cryptogams, and the writer is greatly indebted to Mr. I. H. Burkill for the determination of the former, and to Mr. H. N. Dixon for the determination of mosses. The writer is responsible for naming the Pteridophytes and has attempted to identify the more important of the Liverworts which form such a conspicuous feature of the vegetation.

Climatic conditions.

During the seven days spent on the upper part of the mountain, the summit was covered with cloud every night, but either in the morning or later in the day the cloud lifted, forming again about sunset or earlier. One evening light clouds were formed on the summit about sunset (6 p.m.), but soon disappeared; and no more came till about 9 p.m. Every morning, whether there had been rain or not, the bryophytes on the trees and ground were saturated with water from the clouds. Rain occurred on four days out of the seven, but only once at all heavily. On the finest day the bryophytes were very much dried up, except in the most sheltered places, and the leaves of Hymenophyllums were distinctly shrivelled.

Unfortunately no daily record was kept of the direction of winds, but on those days on which the facts were noted the evening winds forming the clouds came from the south-west. This is probably a seasonal matter, dependent on the monsoons. Lying to the south and south-west of G. Belumut are two or three other lower ridges stretching east and west. Lines of cloud formed first on these ridges, but did not pass on as such to Belumut. The wind blew up the southern slopes of the mountain, forming cloud as it ascended, and the summit was soon covered with thick mist. Judging by the appearance of cloud formation as observed on the other ridges, the cloud was continually added to from the south and dissipated by the continuing wind towards the north. In these circumstances the southern slope would receive most of the moisture, and no doubt this condition prevails throughout the south-west monsoon. During the north-east monsoon there may be heavier rain and more continuous clouding, affecting the south slope considerably as well as the north.

Observations of temperature were not made. When sunny it was quite hot on the summit, probably not much cooler than the low



At the junction of the Matonia-scrub with the mossy forest, on the western ridge Gunong Belumut.

country, but in the cloud and at night it was much cooler, probably down to about 15° C.

Geology; Soil conditions.

The writer is indebted to Mr. G. R. Fulton for particulars of the geological nature of the country round G. Belumut. This mountain and the ridges south of it (of which the nearest, G. Berchuak, was ascended) are formed of hornblende granite, while the ridge to the north, of which G. Berhidong forms the highest part, is of rhyolite.

On the eastern ridge of G. Belumut, just below the summit, in the forest, there were nearly 30 cm. of dark soil above the weathered granite which formed a yellowish clay with much grit. The upper layers of the soil contained many small roots but very little of undecomposed plant material. The lower layers contained less organic matter and were more gritty. Granite of this character may weather to a stiff clay, but it is possible that in such exposed positions as these ridges the silicates may be first weathered and partly washed away before the grains of silica are decomposed, the result being a more or less sandy soil. On the north face, in more open places in the Matonia scrub, the soil is very sandy and has a much thinner layer containing humus. On the south face, where the slope is steep with many large boulders, the soil is largely present in hollows and crevices between the rocks, which are themselves covered with a more or less thick mat of vegetation, at least of bryophytes and ferns.

The rhyolite of G. Berhidong gives a fine clay soil with hardly any sand, and it would be interesting to know whether the vegetation on its summit shows any difference from that on G. Belumut. Unfortunately an attempt to make the ascent failed, and time was not available to make a second.

The Mossy Forest.

1. General.

The best development of the mossy forest is on the south slope. This is far steeper than that to the north, with very large boulders of granite. The trees here are fully 30 ft. in height. Their trunks up to almost shoulder height are thickly covered with masses of liverworts and, less abundantly, mosses. Higher up, the covering of bryophytes is thinner, and different species are found. The uppermost part of the tree often bears lichens, which sometimes encroach on the mosses, and phanerogamic epiphytes. On the ground (here very uneven) is a carpet of mosses; herbaceous vegetation is not well developed, but several species occur, as well as pandans, a few palms, and ferns. Locally a bamboo (*Dendrocalamus flagellifer?*) is quite abundant. As one climbs up on to the ridge there is a sudden dwarfing and much closer growth of the trees, most of which are here not more than 25 feet, the bases still covered with enormous spongy masses of liverworts. Continuing over the ridge on to the north slope, one comes out into the open scrub (See Plate II).

2. The Trees.

Walking in the forest down the ridge westwards from the summit, the following were noted as the largest trees seen. Only those of 30 cm. or more in girth were measured.

Number measured.	Species.	Maximum girth.
8	Calophyllum canum	46 cm.
6	Tetractonia n. sp.	68.5
5	Podocarpus neriifolius	91
4	Gordonia imbricata	56
3	Tristania merguensis	46
3	Eugenia caudata (?)	76
2	Parinarium parviflorum	45
2	Eugenia oblata (?)	43
1	Garcinia sp.	38
1	Quercus rassa	38

The *Tristania* was not seen flowering, so that its identification is not certain, but it is most probably the species named, which is abundant on Mt. Ophir.

An area of about 20 feet (6.1 m.) square was selected, situated on the top of the south slope, one edge being almost along the summit of the western ridge, near the summit of the mountain. In this all woody plants (rattans excepted) above 2 m. in height were measured as regards diameter at breast height, and their total height estimated.

The following is a summary of the measurements made in the selected area. Many of the trees were not flowering or fruiting, and their identification is consequently somewhat doubtful, especially in the case of Eugenia.

No. of individuals.	Species.	Diameter. Max.	Diameter. Mean.	Max. height.
14	Eugenia caudata	10.2 cm.	4.3 cm.	7 m.
14	Eugenia oblata	11.4	3.8	9
10	Eugenia microcalyx	6.4	3.6	9
5	Calophyllum canum	10.2	6.9	10.5
5	Adinandra sp.	4.3	2.8	7.5
4	Garcinia diversifolia	12.7	5.1	9
3	Eugenia subdecussata	7.6	4.3	7.5
3	Wikstroemia Candolleana	3.8	2.8	3.5
3	Symplocos adenophylla	8.1	4.3	9
3	Pandanus sp.			5
3	Elaeocarpus petiolatus	1.3	1.3	2.5
3	Ilex Griffithii	4.8	3.6	7.5
3	Pinanga disticha			2.5
3	Xanthophyllum Wrayi	11.4	4.8	7.5
3	Daphniphyllum laurinum	11.4	8.1	9
2	Eugenia venulosa	10.2	7.6	7.5
2	Quercus Rassa	7.6	5.6	9

No. of individuals.	Species.	Diameter. Max.	Mean.	Max. height.
2	Myrsine Porteriana	8.7	5.6	7.5
2	Lasianthus sp.	3.3	2.2	5.5
1	Eugenia bracteolata	4.6		6
1	Microtropis ophirensis	2		2.5
1	Eugenia claviflora	4.6		3.5
1	Quercus Wenzigiana	2.2		3.5
1	Elaeocarpus parvifolius	2		3
1	Gaertnera Königii	2		2.5
1	Timonius penangensis	4.6		6
1	Vaccinium Teysmanni	1.3		2.5
1	Tristania merguensis	1		2
1	Ardisia sp.	2		4.5
1	Tetractonia sp.	7.6		10.5
1	Podocarpus neriifolius	28		9
1	Palaquium obovatum	15.2		10.5
1	Parinarium parviflorum	8.7		9
1	Lindera bibracteata	2		2.5

Mean diameter of all trees measured 4.5 cm.

Only one specimen of *Podocarpus neriifolius* was present in this plot, being a very old tree lying over obliquely, its topmost shoots reaching about 9 m. vertically above the ground. This species was quite abundant in the mossy forest, though probably less so than in the Matonia scrub and when one looked at the slopes of the mountain from the summit or from the neighbouring peak of G. Berchuak, its pale yellow-green foliage showed up strikingly. The disappearance of the Podocarp on the lower slopes was practically coincident with the lower limit of the mossy forest.

Gordonia imbricata and *Tetractonia* sp. have very much the same habit and form of leaf, and it was not found possible to distinguish the two with certainty from a distance. Both are taller than the majority of the other trees and have a very open mode of branching, with few large rounded leaves. On looking along the ridge from the summit of the mountain one was at once struck with the way in which these two trees both projected above the general level of the forest. They were also both prominent among the isolated trees in the Matonia scrub, and grew taller there also than any others. It was not possible to decide which was the more numerous, but it is thought that the *Tetractonia* is probably so, at least in the scrub.

Calophyllum canum was one of the most striking trees as one walked through the forest, on account of its very straight growing trunks. The smaller leaved *C. venustum* was less abundant.

Tristania merguensis was found particularly in the scrub, but also in the forest, especially on the ridge. There were often very old trees in the transition zone between forest and scrub, with very thick bushy branches, some apparently dead.

The above were the most noticeable of the larger trees; of smaller trees the list shows that Eugenias make up a large proportion.

It is very noticeable that all the trees are of xerophytic character, with small simple usually entire coriaceous leaves.

The mean diameter of 4.5 cm. indicates that the forest is of close growing slender trees. On approximately 400 square feet (37 sq. metres) 103 woody plants of more than 2 m. in height were recorded, giving an average distance apart of about 2 ft. (60 cm.) The thick growth of liverworts round the bases of all plants increased the apparent closeness of the trees. The oldest trees were sometimes fallen over obliquely, one being noticed almost fallen to the ground with several upright branches growing from it. For the most part the small trees grow fairly straight. There is little or nothing of the formation of aerial supporting roots, described as characteristic of the mossy forest on Mt. Maquiling, Luzon. On the south slope where the mossy forest is best developed the steepness and the presence of large granite boulders prevent the trees from growing so closely, but here, being more protected, they are on the whole taller and have larger crowns; the bamboo is also more abundant. A slender *Pandanus* is fairly frequent in the forest, and is often quite tall, while small plants of a broad leaved species, possibly *P. atrocarpus,* were found quite near the summit of the mountain.

Plate III shows a typical part of the forest close to the area in which the trees were measured.

Undershrubs were few. The following were collected: *Allomorphia exigua, Memecylon Hullettii, Gelonium glomerulatum, Daphniphyllum* sp., *Ardisia* sp., *Goniothalamus macrophyllus, Elaeocarpus petiolatus.* These are all quite large leaved in comparison with the trees of the forest, and the leaves less coriaceous.

Pinanga disticha was fairly frequent, and also a rattan, *Calamus brevispadix* Ridl. A second *Calamus* and a *Daemonorhops* were not so common. *Freycinetia valida* was present.

3. Ground vegetation.

(*a*) ***Herbaceous flowering plants.*** These were never very abundant. The following were the most abundant species, and, with seedlings of woody plants, formed the chief ground vegetation: *Sonerila bicolor, Paraboea pyrolaefolia, Didymocarpus platypus, Pentaphragma sp., Argostemma spinulosum, Cephaelis cuneata, Zingiber puberula, Alpinia rafflesiana* (occasional). *Loxocarpus* sp. and *Sonerila erecta* were found chiefly on granite boulders where only a thin covering of mosses was present. *Balanophora multibracteata* was locally quite common. In the more open parts, especially in the broader transition zone between forest and scrub at somewhat lower altitudes (about 3000 ft.) *Cypripedium barbatum* was very abundant, being the most frequent herbaceous plant.

Typical mossy forest, near the summit of Gunong Belumut, upon the south face.

(*b*) ***Pteridophytes.*** These were not so abundant as might have been expected. Of small species, *Selaginella plumea* Spr. and *S. acutangula* Spr. (?) were frequent, *S. Wattii* Bak. being found chiefly on rocks and among liverworts on tree trunks. The following ferns were frequently seen: *Taenitis blechnoides* (nearly always with simple leaves), *Schizoloma divergens* (less abundantly than at lower altitudes), *Lindsaya repens* (mostly small sterile plants), small plants of *Trichomanes rigidum*, and an *Alsophila* (a species found also on Mt. Ophir, possibly undescribed) the stems of which reached several feet in height. Young plants of the last named were also common. In one place several plants of *Cheiropleuria bicuspis* (Bl.) were found, in the shelter of a large rock. *Tapeinidium biserratum* v. A. v. R. (*Davallia biserrata* and *D. gracilis* Bl.), both less and more divided forms, were found in more open places on the south slope. *Gleichenia linearis, G. laevigata* (Willd.) *G. glauca* (Thb.), and *G. hirta* Bl. were occasional throughout the forest, usually with long petioles which carried the leaves up among the branches of the trees. *Lycopodium casuarinoides* Spr. had the same habit, often with stems several yards long, especially on the ridges; its thickly tufted leafy branches, bearing very numerous strobili, were very abundant amongst the bushes close to the summit. *L. cernuum* was also present, but not in such quantity.

(*c*) ***Bryophytes.*** A large part of the ground surface had some growth of mosses or liverworts, in addition to those present on the trees. It was difficult to estimate the relative abundance of these, as the writer was not familiar with the different kinds. Conspicuous were *Leucobryum javense* (Brid.) Mitt. and *L. Bowringii* Mitt., and thick tufts of *Rhizogonium latifolium* Bry. Jav.; *Sematophyllum secundum* (Hornsch. and Reinw.) was also frequent. No doubt other smaller mosses were equally abundant. *Trichosteleum Boschii* (Doz. and Molk.) Jaeg., *Trismegistia rigida* (H. and Rw.) and *Isopterygium albescens* (Schwaegr.) Jaeg. were also found on the ground. Liverworts were not so numerous as on the trees, but species of *Metzgeria* and *Aneura* were common both on the ground and on the bases of the trees.

4. Epiphytes.

(*a*) ***Bryophytes.*** The liverworts present in greatest quantity were *Mastigophora diclados* (Brid.) Nees, which was present everywhere and appeared to withstand considerable dessication, and a large species of *Bazzania*. The *Mastigophora* formed almost pure cushions, sometimes several inches in thickness, round the bases of many of the trees. Mixed with it were small quantities of more delicate species of *Frullania*, and various other plants which appear referable to the genera *Bazzania*, *Chiloscyphus* and *Plagiochila*. *Lepidozia subintegra* Lindenb. (?), a very fine hair-like species with minute leaves, was often present in masses, sometimes mixed with *Mastigophora diclados*. *Trichocolea tomentella* (Huds.) Nees, was also fairly abundant.

Of the less abundant species a handsome large-leaved *Schistochila* was very noticeable. A *Pleurozia* was found chiefly on the upper part of tree trunks, where no other species would grow. Its habit of growing very closely appressed to the surface of the bark is no doubt an advantage in such situations. Where it was most exposed it was often deep red in colour. It was often fertile.

Of Mosses *Nematophyllum secundum* and *N. rigens* Broth. (previously collected only on Mt. Ophir) were recorded as present on the lower parts of tree trunks. On the upper branches of the trees, in very exposed situations, were found large compact cushions of *Syrrhopodon borneensis* (Hpe.) Jaeg.

The upper branches of the trees had also lichens on them, but these were not collected. One of the lichens was often seen growing over and apparently smothering bryophytes growing in rather exposed positions.

(*b*) ***Pteridophytes.*** The most abundant epiphytic fern was *Hymenophyllum serrulatum* (Pr.), an unusually slender form. *H. denticulatum* Sw. was also common. A very small species, apparently closely allied to *H. borneense* Hk., was found twice only. These all grew among the liverworts on the tree trunks. Usually somewhat higher up, also among bryophytes, the following were quite common: *Polypodium decorum* Brack., *P. malaicum* v. A. v. R., and a small species near to *P. cornigerum* Bak.; *Scleroglossum sulcatum* (Mett.) v. A. v. R. was not so frequently noticed, and *Polypodium cucullatum* Nees and Bl. was seen once only. On still higher branches *Humata repens* (L. fil.) was occasionally present: and *H. heterophylla* (Sw.) and *Oleandra neriiformis* Cav. (both sterile) were each seen once. One plant of *Lycopodium phlegmaria* was found in a very exposed position on the upper branch of a tree in the scrub; it was very stunted.

(*c*) ***Phanerogams.*** Epiphytic flowering plants were not very numerous. They were found on trees both in the forest and in the scrub. The most striking were *Pachycentria tuberculata, Medinilla Clarkei* (also on rocks on summit) and another *Medinilla*. *Dendrobium uniflorum* and *Ceratostylis gracilis* were the only orchids at all abundant in exposed positions; in the forest, on lower branches, *Podochilus sciuroides* was frequent. *Eria poculata* was occasional, also *Bulbophyllum* and *Coelogyne* sp., not in flower. *Rhododendron jasmini florum, R. longiflorum, Elytranthe retusa* and *Hydnophytum formicarum* were occasional, also a small *Dischidia*. *Corysanthes mucronata* was found in several places growing in the masses of liverworts on the tree trunks, apparently just come into flower. Its tubers and roots were embedded in the spongy substratum, the small solitary leaves and flowers showing just above the surface. Some of the plants were exceedingly minute.

Of climbers, *Nepenthes ampullaria, N. Rafflesiana* (?) and *Smilax laevis* were frequent, but more usually present in the more open scrub.

The Matonia scrub.

Near the summit of the mountain, this vegetation consists typically of a close shoulder-high growth of *Matonia pectinata*, associated with various plants of similar stature, and isolated trees and shrubs of varying size. The most important of the former are *Pandanus ornatus, Gahnia javanica, Lepidospermum chinense* and *Dipteris conjugata*. *Dipteris* is not found in the most exposed places, being obviously less xerophilous than *Matonia*, and though almost always present was never seen dominant. The orchids *Spathoglottis aurea* and *Bromheadia palustris* were quite abundant; and *Euthemis leuccocarpa* was occasionally seen. Underneath the *Matonia*, and especially round the bases of trees and shrubs, mosses and liverworts covered the ground as in the forest.

In the most open places, on very sandy soil, *Gleichenia circinata* and *Actinoschoenus filiformis* were the dominant plants, and here also on the ground were noticed the more xerophytic liverworts and *Leucobryum* spp.

The following trailing and climbing plants were frequent: *Nepenthes ampullaria, N. ? Rafflesiana, Dissochaeta annulata, Vitis gracilis, Smilax laevis*, and *Lycopodium casuarinoides*. *Gleichenia linearis* was present, but never abundant.

The most conspicuous trees also present in the mossy forest were: *Tetractonia, Gordonia, Podocarpus, Calophyllum* spp., *Tristania*. *Podocarpus* was very abundant, including many small plants, and its yellowish foliage made it conspicuous. All the trees were somewhat dwarfed as compared with their growth in the forest, *Calophyllum* most markedly, *Tetractonia* and *Gordonia* least so. The larger trees had a very weather-beaten appearance. Epiphytes were few, and stunted owing to exposure.

Other woody plants noted as frequent were *Quercus Rassa* (producing fruit at a height of only 3 feet) *Timonius pinangensis, Symplocos adenophylla, Melastoma* sp., *Elaeocarpus reticosus, Adinandra dumosa, Hedyotis congesta, Ardisia Barnesii*. On the very summit, surrounding the few huge granite boulders, was a very dense growth of shrubs, with some *Matonia*. *Freycinetia valida* was climbing on these, and *Scleria* sp. was collected. Under the shade of the rocks grew a *Lophatherum*. On the boulders were a few epiphytes, including *Medinilla Clarkei, Sonerila erecta, Bulbophyllum* sp., and *Humata repens*.

Some 300-400 feet below the summit, on the western ridge, the trees in the scrub were much larger and closer, and the *Matonia* much less, and a broad transition zone between scrub and forest developed, in which *Cypripedium barbatum* was very abundant. The transition from scrub to mid-mountain forest was not seen.

The same scrub was found on the northern face of Gunong Berchuak to the S. E. of Belumut. This hill has twin summits close together, both about 3,000 ft. above sea, and it was interesting to find that on the northern side of the southern summit there was still open Matonia scrub.

Comparison with other descriptions of mossy forest.

There are various references in Mr. Ridley's papers to mossy forest on the mountains of the Malay Peninsula, but no detailed account anywhere. It seems probable that everywhere in the cloud belt dwarfed mossy forest prevails, while the tops of the highest peaks in the main range are covered with a xerophilous scrub in which Matonia is usually present. On isolated hills such as Kedah Peak* the mossy forest is found at much lower altitudes than on the mass of the main range, and the same is true of Belumut. The peculiarity of Belumut in having mossy forest on the south slope only must be due to local conditions of weather and topography. The scrub and forest on Belumut appear to correspond with the open rock vegetation and the valley woods of the Padang of Gunong Tahan as described by Ridley.[1] There is no detailed description of the vegetation of the top of Mt. Ophir, (distant 66 miles from Belumut) but most of the species collected on Belumut have been found also on Mt. Ophir.[2] The writer cannot however attempt a floristic comparison in the present paper.

The Belumut mossy forest appears to be very similar in general organisation and appearance to that described by Miss L. S. Gibbs on Mt. Kinabalu in British North Borneo,[3] though most of the species are different. Miss Gibbs' Pl. 6 fig. 3 shows a tree of *Leptospermum flavescens* which has a very similar habit to the *Tristania* on Belumut. In another paper Miss Gibbs has short notes on similar forest on the ridges of the Arfak Mountains in New Guinea.[4]

The mossy forest on Mt. Maquiling in Luzon described by Brown[5] differs in various respects, but it is said that all such vegetation on the Philippines is not quite of the same type (p. 102). The differences from Belumut are principally in the prevalence of plants with aerial roots, and in the greater abundance of tree ferns and herbaceous ground vegetation. On Mt. Maquiling the growth of woody plants was about as dense as on Belumut, 157 individuals representing 17 species being recorded on 50 sq. metres; on Belumut 106 individuals representing about 30 species were found on 37 sq. metres. On Mt. Maquiling there was a bigger proportion of plants with non-entire leaves on the summit than at lower altitudes, whereas on Belumut the only tree with noticeably toothed leaves was *Parinarium parvifolium*. On both mountains trees of the mossy forest all have simple and rather small leaves.

The brothers Sarasin give brief descriptions of mossy forest on the mountains of Celebes,[6] and some photographs.

*See Ridley, *Journ. S.B.R. Asiatic Society* No. 34 pp. 23-30 (1900).

1. *F.M.S. Museums Journ.* Vol. 6. p. 132. (1915).
2. See Ridley's paper in *Journ. S.B.R. Asiatic Society*. No. 35 pp. 1-28 (1901).
3. *Journ. Linn. Soc. Bot.* Vol. 42 pp. 1-240 (1914).
4. *A contribution to the phytogeography and flora of the Arfak Mountains* etc. (Read before the British Assn. 1916) Taylor and Francis, London.
5. Brown, W. H.; *Vegetation of Philipine Mountains.* Manila, Bureau of Science publication No. 13 (1919).
6. Sarasin, P. & F. *Reisen in Celebes.* Wiesbaden, 1905.

Giesenhagen (*Ann. Jard. Bot. Buitenzorg,* 3rd. Suppl. pp. 711-789, 1910) gives a description of the conditions under which a great development of moss growth occurs in various localities in Java and Sumatra, with a discussion of the growth-forms which mosses assume. He does not deal with the conditions under which the different growth-forms appear. There is a reference to this, however, in a short paper recently published by W. Seifriz (*Journ. of Ecology,* Vol. 12, pp. 307-313, 1924) in which the altitudinal distribution of mosses and lichens on G. Gedeh in Java is discussed. From about 5500 to 7000 feet there is a moss zone, in which the pendent type is very abundant; this is the zone of *Podocarpus imbricatus.* The next zone, from 7000 to 8000 feet is "very open in character, with a prolific growth of herbs on the forest floor. Mosses and lichens are very poorly represented." The highest zone, 8000 to 9200 feet, is "a foggy, windswept region typified by small gnarled trees, mostly of the genus Vaccinium." In the lower part of this zone there is much moss growth, but entirely of compact tufted forms, clinging close to the tree trunks; the cause of the difference between this and the lower moss zone is ascribed to the great force of the winds in the higher zone, accentuated by the lower stature of the trees. In the upper part of this zone the vegetation is more open, and the consequent greater light and reduced humidity account for the replacement of mosses by lichens. The conditions on G. Belumut are quite different, probably owing to the limited range in altitude of the cloud zone. There is nothing comparable to the great development of the pendent type of moss found in the fairly high Podocarpus forest on G. Gedeh. It needs more protection from wind than is found in the dwarf forest on Belumut. Closer growing mosses are found, but again not exclusively, as in the upper zone on G. Gedeh. The great preponderance of liverworts is not described at all from G. Gedeh; there must be on G. Belumut conditions favourable for the growth of liverworts, particularly of *Mastigophora diclados,* which are absent from the upper zone on G. Gedeh.

Regarding the biology of liverworts, a paper of Goebel's is of importance (*Ann. Jard. Bot. Buitenzorg,* 7, pp. 21-69, 1888). He describes the various water-holding lobes present on the leaves of many species, distinguishing three types; species possessing these are all epiphytic. The only notable species on Belumut that comes under any of his categories is the Pleurozia (Physotium), which is among the most specialised of all. It occurs in exposed places on the upper parts of tree trunks, where its large water sacs are of great service. Frullanias were not found abundantly on Belumut; two species grew amongst the Mastigophora, no doubt partly protected by it. Mastigophora itself possesses no water sacs; its finely divided small leaves are able to hold a certain amount of water, but it will dry up fairly easily. Probably its habit of growing in large spongy masses prevents complete dessication of the whole plant.

Karsten (*Ann. Jard. Bot. Buitenzorg,* 12, pp. 119-122, 1892) gives a list of liverworts found in Amboyna, on mountains 1250 and 1050 m. (4100 and 3450 feet). At about 700 m. Agathis was found, and above the Agathis a dwarf forest of Leptospermum, Vaccinium, Podocarpus etc., the trees being overed with bryophytes. He mentions particularly very fine species of Schistochila (*S. sciurea*) and Pleurozia species of which were also among the most conspicuous liverworts on Belumut. He gives a list of species, including *Mastigophora diclados,* but this is not mentioned as specially abundant.

Causes of the development of mossy forest.

Brown states that mossy forest is confined to the cloud belt (l. c., p. 103), and this appears to be well borne out by all other records. The great abundance of mosses, liverworts and Hymenophyllaceae, in varying proportions, is a feature which probably could only occur in such situations. It does not seem to have been pointed out, however, by previous writers, that these plants may have frequently to stand a considerable degree of dessication, as was undoubtedly the case on Belumut. The second feature which all these forests have in common is the dwarfing of tree growth. The heavy growth of epiphytes has been suggested as one cause, but this alone cannot be responsible, since trees in the open scrub on Belumut were more dwarfed than the same species in the forest. Brown, by careful correlation of many measurements of environment conditions at different altitudes on Mt. Maquiling, concludes that the dwarfing is due to a combination of lowered temperature and decrease in light intensity as compared with conditions on the lower slopes of the mountain.

Miss Gibbs' suggestion (Kinabalu, p. 47) that mossy forest may be due to edaphic factors, leading to the conclusion that it is a secondary formation, does not seem to be well founded, though doubtless edaphic factors are responsible for variations in its composition and physiognomy. Brown remarks that mossy forest probably does not constitute a single homogeneous type, but that our present knowledge does not suffice to classify the various forms it may adopt, and this seems a very reasonable conclusion.

The pioneer vegetation on the summit of Gunong Belumut must have been of a xerophilous nature, owing to the fact that clouding is not continuous and that there are intervals of considerable insolation. Matonia scrub therefore probably represents an early stage in the development history of the summit vegetation, becoming transformed gradually into mossy forest in those parts where clouding was most frequent. The condition of the north slope thus represents as arrested early phase in the development, which is doubtless in equilibrium, having reached as advanced a stage as conditions will permit. Edaphic factors may be partly responsible for this arrest in development, but observations made up to the present are too limited for any definite opinion to be given.

Considering the mossy forest as the climax plant association of the cloud zone, it is interesting to compare it with climax associations of temperate regions. The most striking fact which is at once evident is that we have here no single dominant species. We appear rather to have present a number of species of about equal stature no one of which has sufficient advantage over the others to approach dominance. All have rather small simple leaves decidedly coriaceous in texture. The most numerous appear to be various species of *Eugenia*. In their variety these trees agree rather with the second storey of the Dipterocarp forest than with the upper storey, in which there appears to be definite dominance of one or a few species. *Gordonia* and *Tetractonia* and possibly others certainly project above the bulk of their neighbours, but it is doubtful whether they protect the other trees in any way.

R. E. Holttum.

TWO HYBRID TREES OF HEVEA BRASILIENSIS×H. CONFUSA.

In the Gardens Bulletin, II (1919) p. 113, an account was given of a *Hevea* tree found in the Economic Garden, and determined to be *Hevea confusa*. That species is known to be a very inferior producer of rubber, and a danger to rubber-cultivation where its presence can lead to hybridisation. For that reason the tree was destroyed at once. It had newly fruited and seedlings had been raised of which two were kept for observation in a remote part of the Botanic Garden.

Those two have just flowered at the age of five years, and been destroyed in their turn, so that nothing of the objectionable type persists. They had been under observation through their growth, and their flowers have been very carefully examined: the result has been a complete demonstration that both trees were hybrids with H. *brasiliensis* as the male parent.

This demonstration of cross-pollination between the two species is not as interesting as another given by Mr. H. C. Pearson in the *India Rubber World* for October 1st, 1919, p. 46, for in that, seed of a fine *H. brasiliensis* in Trinidad produced plants which showed *H. confusa* in their constitution originating from a tree one-hundred yards away, the distance between the two parents having been very much less in the Singapore. But it is interesting as a demonstration of the great degree to which cross-fertilisation is carried in the Rubber tree. It is a cross in the opposite direction to Mr. Pearson's namely of male *H. brasiliensis* on female *H. confusa*. It is also a lesson that from a plantation of even pure *H. brasiliensis*, if first class seed is wanted, the inferior yielders should be removed, as cross-pollination occurs to such a great extent.

The two hybrid trees of the Botanic Gardens differed between themselves. The one had darker bark than the other, and leaves with more of the arching in them that characterises *H. obtusa*. Both had the white latex of *H. brasiliensis*, but that meagre as in *H. confusa*. When the flowers appeared, the males were found intermediate in shape, and to face earthwards as in *H. confusa*, and were softly downy outside, but the anthers were as in *H. brasiliensis*. Female flowers were very few, probably because the trees were flowering while still too young for full reproductiveness.

I. H. Burkill.

VARIETIES OF DIOSCOREA PENTAPHYLLA IN MALAYSIA.

This widely distributed species occurs in several varieties in Malaysia and with our present knowledge five may be defined. They are:—

Tubers elongated: rusty hair abundant on the above-ground parts: the leaflets broad .. .. *malaica*

Tubers not elongated: so that their length is not twice their greatest diameter:

Tubers not flattened, abundantly covered with roots, much lobed: rusty hair abundant on the above-ground parts: leaflets broad:

Leaflets large, up to 20 cm. by 6 cm.: flowers large: numerous large simple leaves produced among them .. .. .. *papuana*

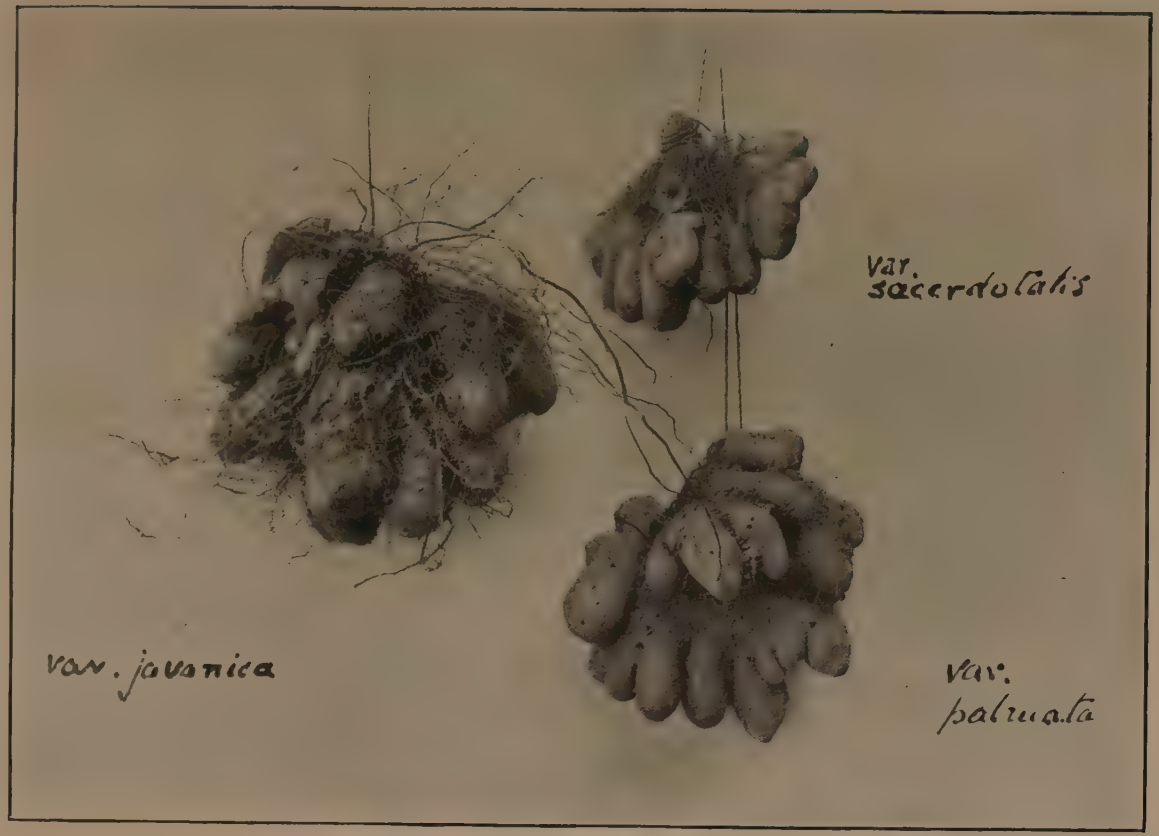
Leaflets smaller, up to 10 cm. by 3.5 cm.: flowers small: simple leaves about 2 cm. by 2 cm. .. .. *javanica*

Tubers conspicuously flattened and relatively free from roots, much lobed: grey hairs present in the place of rusty red hairs;

Leaflets relatively large, up to 20 cm. by 4 cm.; flowers rather large: tubers as far as seen larger than in the next .. *palmata*

Leaflets relatively small, up to 14 cm. by 3.5 cm.: flowers relatively small: tuber as far as seen smaller than in the last .. *sacerdotalis*

The variety *malaica* is that which furnishes the "ubi jabbet" of the Sakais in the centre of the Malay Peninsula, and they not only eat it from wild sources but plant tubers in the neighbourhood of their houses. The Sakais of Northern Perak have another name



Tubers of three varieties of Dioscorea pentaphylla.

for it, *i.e.* "kasu," and they too eat it. The variety *papuana* furnishes a food eaten in the neighbourhood of Port Moresby, where it grows wild, and is considered as of two kinds called "maloa" and "bakuta." The variety *javanica* is the wild plant of Java. The variety *palmata* occurs in cultivation in the Philippine islands, and the variety *sacerdotalis* in cultivation in Java.

As a help towards the definition of these varieties the plate opposite gives figures of three of them. Four tubers of the variety *malaica* were figured in this Bulletin in the plate in no. 3 of volume II, opposite p. 92.

The writer has eaten *D. pentaphylla*, var. *palmata* and found it good. As yet the variety *sacerdotalis* has not been eaten. The tubers of the other three varieties are certainly nauseous.

There is a kind in Papua near Port Moresby known as "lebeta" which seems to differ from the above, and needs more study.

With the knowledge to hand at present it is impossible to identify the three forms of *D. pentaphylla* which Rumpf described in his *Herbarium Amboinense*, lib. ix., cap. xiv. He called them "the white," "the red" and "the fusc."

The white, he stated produces the largest tubers; they have the outline of a hood or cape, that is to say expanding downwards; and the lower margin ends in lobes. The upper part carries too much fibrous tissue to be eaten; the lower part is softer and can be eaten, but possesses a vile flavour. The red, he described as smaller, and a better food. The fusc colours the water in which it is boiled blackish and boils black itself. All three were to be found in the island of Bima i.e. Sumbawa: the red was also in Buru and Bali: one or another was also in Celebes, Amboina and the Moluccas, but he does not specify which. His figure more nearly suggests var. *javanica* than the others. It appears then that to fully understand Rumpf attention must be turned to Sumbawa.

In the last issue of this Bulletin, on p. 137, attention was called to certain interesting sanskritic names applied in Java to *Dioscorea pentaphylla*, and it was suggested that they indicate a religious use of the tuber as a food for fast days, similar to the use by the Hindus of Upper and Central India of *Dioscorea esculenta*, and of a meal made from *Dioscorea hispida*. These sanskritic names belong to the variety *sacerdotalis;* but there is no indication that the Hindus brought the variety into their kingdoms in Java with their religion; they found it probably in Malaysia and adopted it.

I. H. Burkill.

DIOSCOREA PISCATORUM OR TUBA-UBI, A FISH-POISON.

Dioscorea piscatorum, Prain and Burkill, is a newly published name for a plant which appeared in Mr. Ridley's *Materials for a Flora of the Malay Peninsula, Monocotyledons*, 2, (1907) p. 84, as *Dioscorea* sp. He had made acquaintance with it from a sterile herbarium specimen collected by Mr. A. D. Machado of the Kemuning Estate in Perak; and then about the same time a reward was offered at an Agri-Horticultural exhibition in Kuala Lumpur for a collection of such fish-poisons as act like Derris; and in one of the competing exhibits was a tuber labelled "tuba-ubi" which Mr. Ridley, acquiring it for the Botanic Gardens, Singapore, identified as the Dioscorea collected by Machado (*Agric. Bull. Straits and F. M. S.*, 7, 1908, p. 443). He grew it until 1912; but it did not flower and no specimens were preserved. In 1915 a plant was found on Pulau Tiuman with the characters of Machado's; but it was impossible to get it into cultivation as it was in full growth. In 1921 herbarium specimens and tubers, corresponding closely, were got from Sibolangit in Sumatra. These are in cultivation in the Singapore Botanic Garden, and the piscicidal properties have been proved, as the following note shows. A tuber from Sibolangit was figured in this Bulletin in the plate opposite p. 4 of the current volume, under the title of "a spiny yam from Sumatra."

Half of a tuber about 15 cm. long was pounded up with water. The tuber was very fibrous and light reddish in colour; the juice was slightly milky, with a soapy froth, and of the same colour as the flesh. It was poured into a vessel 60 by 38 cm., into which water had been run to a depth of 10 cm. Eight fish of the species *Puntius binotatus* (Cuv. and Val.) of length varying from 6.5 to 10.5 cm., freshly caught from the Gardens lake, had previously been placed in the vessel, and were swimming about vigorously. When the juice of the tuber was poured in, the fish at once appeared uneasy. They swam round and round the vessel rapidly, and frequently came to the surface with open mouths; then their movements gradually became less and in under ten minutes they turned over, floating motionless for a few seconds at a time, showing their white lower surface. The quiescent periods grew longer, and after a few more minutes active motion was occasional, and only by slight vibrations of fins and tail. When in this condition they were transferred to fresh water, but the poison had gone too far to admit of recovery and in a few minutes more they were quite dead.

We are indebted to Mr. F. N. Chasen of the Raffles Museum for the identification of the fish.

I. H. Burkill.

R. E. Holttum.

A STUDY OF THE COCONUT FLOWER AND ITS RELATION TO FRUIT PRODUCTION.

Introduction.

The literature on the biology of pollination and fruit production of coconuts is extremely sparse and what little is available is distributed in numerous books and periodicals so that investigators have experienced great difficulties in consulting them. An attempt is made here to bring together all the available studies on the subject, including my own observations, a part of which have already been published in the *Poona Agricultural College Magazine* and the *Agricultural Journal of India* (10).

I am indebted to Mr. I. H. Burkill for the information quoted in this paper from the German and Dutch books and to Mr. F. N. Chasen for the identification of some of the insect visitors to coconut flowers.

The Inflorescence.

Coconut inflorescences are formed in the axils of every leaf of a bearing tree and not of every third leaf as some writers have supposed (8) & (17). It is true that some axils fail to throw out any inflorescences, but this is because these inflorescences have become abortive; and even then these aborted inflorescences do not bear any definite relation to the others which grow so as to justify the statement that the inflorescences are produced in the axil of every third leaf. A very prolific tree will produce twelve or more inflorescences per annum or approximately one per month. There are records of trees having produced sixteen inflorescences per year (2) & (17).

As the flowers appear in the axils of leaves, it will be worth while to know that the leaves are arranged on the stem in the form of a spiral so that every sixth leaf opens, nearly above the first one, that is, each leaf opens according to the calculation of Sampson in India (21), at an angle of approximately 142° round the circumference of the tree from the previous leaf. In Goa the coconut harvester divides the coconut trees under two classes, the right- and left-handed ones, according as the spirals formed by the leaves and, therefore, by the inflorescences, are right or left. Both Costa (8) and Loyola (17) who maintain that the coconut inflorescences arise in the axils of every third leaf give correct diagrams of the phyllotaxis of the coconut inflorescences. They were probably misled in their observations on the orientation of the coconut inflorescence by their mistaken view that the coconut leaves are arranged in concentric circles and not in a spiral.

The inflorescences first appears enclosed in a thick, fibrous sheath called the spathe which is again protected during its early life by one more yellow sheath of somewhat flat nature and of softer fibres. This outer sheath stops growing very early in the life of the inner spathe so that the latter punctures it with its hard point on

its ventral side (*i.e.* the side towards the subtending leaf) and comes out erect as a yellow somewhat flattened cone, which later on as it grows, turns green, curves a little outwards and becomes more round than flat. In course of time when the spathe is of full grown, the development and distension of the inflorescence within causes a great pressure on the walls of the spathe with the result that it ruptures longitudinally along a groove usually on its ventral side and the flowering branch eventually emerges: sometimes, however, the rupturing of the spathe takes place on its dorsal side but then the spadix turns round till the inflorescence within falls out. The process of splitting is very slow, the slit which appears at first at a point about an inch and half from the apex, takes about twenty-four or more hours to reach down and give egress to the inflorescence. It is at first yellowish white in colour, but later on it turns greenish and also inclines downwards from its vertical position.

The cocount is essentially a monoecious plant, that is, stamens and pistils are produced in separate flowers on the same tree and in the case of coconuts in the same inflorescence, and, though some coconut palms will at times show a very marked tendency to produce spadices with all florets male, spadices are not usually produced in coconuts where all flowers are female and none male. The tendency to produce completely male inflorescences is particularly apparent when the palm produces the spathe for the first time in its life. There is a great variation in such trees: some will produce their second or third inflorescence with female flowers, while others will bear no female flowers even in the sixth inflorescence. If this variation is due to hereditary qualities, then this factor has also to be taken into consideration in selecting seed-nuts. The tendency to produce completely male inflorescences is at times manifested by trees which are given rest after a prolonged period of tapping for toddy.

The inflorescence itself consists of many flower-bearing ramifications or spikelets situated on a fleshy peduncle: hence the inflorescence is termed a spadix. Its size varies from two and half to six feet in length from the tip to the base, depending upon the vigour and individuality of the palm. Each branch is fringed with numerous male florets from tip downwards and lower down bears one or more female flowers, all the flowers being sessile or subsessile as Aldaba calls it. At times, however, some of these ramifications become spathulate and then partially or wholly sterile. Some of the branches in an inflorescence may produce secondary branches. As far as my observations stands, such inflorescences rarely produce female flowers which may be produced even on the secondary branches. Most of these inflorescences were noticed on trees heavily manured with nitrogenous manures, but I was not able to ascertain whether the manure was responsible for the branching and reduced fertility of these spadices.

The Male Flower.

The male flowers always exceed the number of female flowers in the same spadix and may vary from a few hundreds to thousands, depending upon the number of ramifications in the spadix and the length of the flower-bearing regions in them. Each male floret has six yellow perianth leaves arranged in two whorls, the inner three alternating with others which are about one-third of the former in size. Enclosed in this floral envelope there are six hammer-shaped stamens which yield large quantities of powdery yellow pollen. Aldaba (1) has estimated that each male flower carries about 272, 358, 504 pollen grains. In the centre of each male floret there is a rudimentary pistil which divides at its apex into three teeth, each bearing a gland, the nectar of which attracts ants, bees and other creatures. Rarely this rudimentary pistil is absent (19). A case has been noted where these abortive ovaries were stimulated to grow so that the coconut palm bore, "instead of the few ordinary fruits at the base of the spadix, great numbers of small, crowded, narrow, quite banana-like fruits." (25) The male florets start opening from the tip downwards and liberate pollen, though sometimes a few flowers may open out of order. This opening of male flowers and shedding of the pollen lasts about a month, the inflorescences with secondary branches taking a little more than the usual period.

The Female Flower.

The female flower are comparatively extremely few, their number in each spadix varying from zero to over 300 and being dependent upon the strain, treatment, etc. They are always produced towards the basal portions of the spikelets. Many of the yellow-nut-producing varieties from the Konkan (West Coast of India), for instance, are usually very shy in bearing, while the dwarfish varieties of Goa (the *Benauly* seed) or dwarf varieties of Malaya enjoy the reputation of being heavy producers.

Prior to its opening, the female flower is a small spherical body of about half an inch in diameter with a great resemblance to a small nut. These female flowers consist of six floral leaves which are arranged as in the male flowers and which completely envelope the pistil; but these are much larger and stiffer than those in the male florets, and the outer three are almost equal in size to the inner ones. Apart from these six perianth members, there are two more just at the point of attachment of the flowers to the stalk, resembling the others in colour and texture, but differing from them in that they are broader and shorter. These two may be termed prophylls or bracteoles. Usually there is a male flower on each side of the female resting on the same cushion on which the female is seated. The pistil is a small whitish body consisting principally of embryonic tissue of husk. From its tip there extend downwards three ridges which make the whole ovary look globosely three-sided, each side being provided at its tip with a groove. These three grooves meet in the centre and are the parts of the stigma. It will

be seen by cross-sectioning the pistil that just above the thalamus there is the ovary (embryonic nut) with its three carpels, two of which normally become abortive even at this early stage. Sometimes, however, all three ovules get developed and when fertilised produce a trilocular-nut which on germination gives a tree commonly mistaken for a branched coconut palm.

Pollination and Fertilization.

Before proceeding any further a distinction between Pollination and Fertilization may be made with advantage so as to avoid confusion on this matter. Among the fruit culturists, the term pollination is often applied to designate all the influences concerned in the setting of fruits; and the term fertilization is often given the same significance. In botanical usage, however, pollination means simply transference of pollen grains to the stigma, while fertilization is the fusion of the male element from the pollen with the female element in the ovule, and therefore, conveys the idea that, prior to this fusion, the stigma has to be pollinated and the male element must reach the ovum through the pores in the stigma. Cases, however, may occur where these two stages previous to the fertilization may take place and stimulate the pistil to grow and yet the actual fusion may not eventuate producing seeds destitute of any of embryo. The coconut fruits known as "barren" "imperfect," "male," "man" or "seedless" coconuts are probably a result of such a phenomenon. Such nuts have been observed by me in India and Burma, have been recorded from Jamaica ([16]) and British Guinea ([3]), and probably occur in most places where coconuts are grown. They can usually be distinguished from others by being narrower, and inside have shell-substance and a cavity and sometimes even a diminutive nut with or without some kernel, but no embryo. Apparently the stimulus of pollen is not even necessary for such a development in coconuts, for Bailey ([4]) has written that "Coconuts, like many other fruits, often grow to a considerable size without pollination, and then perish." It must not be ignored, however, that a fruit without an embryo may be the consequence of actual fertilization, but that it does not contain any embryo, because the embryo ceased to grow soon after the fusion of male and female element in the ovule without thereby arresting the development of the fruit. A comparative study of these abnormal coconuts and normal ones from Jamaica made by Kupfer ([16]), indicated that the substance which usually goes to the formation of seed was, in the case of seedless nuts, devoted to increasing the bulk of husk. "Since no trace of fungus, insect, or bacterial activity could be found, no direct evidence as to the cause of the condition of the defective fruits could be produced. The probability is, however, that the responsibility for this state of the fruiting organs is to be laid against none of these agents, but is the result of the failure on the part of flower to effect pollination."

Some coconut trees produce "male" nuts habitually in all seasons of the year and others in certain seasons only of every year

or after a number of years; and still others do not produce male nuts at all or produce only this kind of fruit all their life. Might not this quality be associated with hereditary factors? In many plants, for instance, the production of sterile pollen grains and ovules is due to an inherent factor, though influences such as climate may modify these qualities to a slight extent. On the other hand, there is the possibility that the inability of ova being fertilized lies in the fact that the nutrition is defective; for it has been shown by experiments that weak and poorly nourished orchard trees often produce ineffective pollen, or unfavourable weather conditions cause great losses by preventing the proper maturity of the pollen or pistil. Aldaba ([1]) has shown that desiccating influences reduce the vitality of pollen, while it is a matter of common belief among planters that heavy downpours of rains excessive cold, heat and winds, or prolonged droughts interfere with setting of nuts.

When it began to be realised by coconut planters that ordinarily fertilization was necessary to produce coconut fruits, it was customary to consider all the female flowers, even when they were not ripe to receive pollen, as fertilized or at least pollinated flowers. Thus in 1898 the late J. M. de Sa ([20]), then a District Administrator of the Village Associations of Goa, wrote in his book "O Coqueiro" that he had seen pollinated or fertilized flowers even in unopened spathes: and the same idea was repeated about 14 years later by L. C. Brown ([5]), late Inspector of Coconut Estates in the F. M. S. in a communication made to Mr. H. H. Smith, the senior author of the *Consols of the East*. On this view Fredholm ([9]), who, as far as I am able to make out, was the first man to correct the view, remarked thus:—"But when you state that pollination takes place to a certain extent before the actual full opening of the sheath, so that young fruit, which may or may not properly set, is observed half-formed as soon as the flower-spike comes into view, then you are wrong. You have evidently mistaken the female flower bud for the young fruit (the fertilized ovum). In this plant in-breeding is so exceptionally well guarded against that it is well-nigh impossible, the pollen grains and the ovules of one and the same inflorescence never arriving at maturity simultaneously. On this point I write, in my articles, as follows:—In-breeding or close-breeding is guarded against as much as possible in nature. It is prevented, in the case of the coconut palm, by a difference in the time of expansion of the male and female flowers on the same spadix, and as a palm rarely has more than one inflorescence at a time with open flowers, the pollination of the female flowers is generally brought about by pollen from the staminate flowers of another palm. Thus cross-pollination is the rule. The pistillate flowers do not expand before the staminates of the same spadix have shed their pollen and fallen out. Until that time the gynaecium remains completely covered by the perianth leaves."

Observations made by various other investigators such as Petch ([18]) in Ceylon, Sampson ([21]) in India, and Jepson ([13]) in Fiji, confirmed those of Fredholm's. But though the conclusions

of Fredholm appear to hold good in most of the countries where coconuts are grown, they are not universally true. Not only is there the possibility of exceptions occurring in places where normally the female flowers open when all of male flowers have been shed ([10]), but in certain places as in the warm, humid lowlands of Malaya "the female phase not only begins, but most frequently ends before, or at the same time as, the male phase, thus rendering self-pollination the rule instead of being an occasional chance occurrence ([12])." Messrs. Jack and Sands from whom the above quotation is taken have succeeded in obtaining fruits by bagging an unopened coconut inflorescence, and my observations on the dwarf varieties in the Botanic Gardens, Singapore, lend support to their conclusions. This behaviour of the palms in the F. M. S. may be due to some hereditary qualities; but is also possible to attribute this variation in the anthesis of coconut flowers to climatic conditions and the fact that Van der Wolk ([24]) has shown that the ripening of female flowers is hastened by covering them with black paper so as to reduce light and warmth, may be invoked in support of this

The mode in which the coconut flower presents its stigma for the reception of the pollen is quite different from that of most of our garden flowers. In the latter the petals become loose as the stigma matures, open out exposing the stigma and then after a time wither and drop off. Such however, is not the case with the members of the perianth of the coconut flower. They never drop off unless the ovary or the fruit itself is detached and when young they form a very tight case in which the pistil is protected. The perianth leaves grow extremely slowly attaining the final length of about two to three centimetres, whereas the pistil inside grows comparatively at an enormous rate so that it forces them apart and extrudes the stigma-bearing region, on the ripening of which the stigmatic grooves become exposed to receive pollen. There is a secretion of nectar both from these grooves as well as from the region surrounding them. The period during which the female flower remains receptive varies in different places. At Akyab ([10]) and at Peradeniya ([18]), for instance, it is about 24 hours, while in Los Banos ([1]) and Singapore it is about 2 to 3 days.

Biology of Pollen.

Pollen grains of the coconut are spherical and smooth, without any asperities, but on exposure of a few seconds they turn ellipsoidal with a single meridian groove or suture which, according to Kerner ([14]), is characteristic of palms. On wetting the grains resume their original shape, the longitudinal fold disappearing. This groove seems to point out that coconut pollen belongs to the type adapted to be transported by insects rather than to the type easily wafted by winds. There are two kinds of pollen grains, fertile and infertile, the latter are about half the size of the former. Aldaba's ([1]) countings show that infertile pollen grains vary in the

Philippines from 3 to 33 per cent, but in Singapore the abortive grains appear to be very few.

It is the general belief that pollen grains of palms, when kept in dry condition, retain their fertilizing properties unimpaired for a very long time so that they can be exported to distant countries for the purpose of pollinating certain varieties which are desired to be crossed, and Kerner ([14]) quotes a tradition which says that the pollen of Date-palms together with that of Hemp and Maize, can be used effectively for artificial pollination even after a lapse of eighteen years. Hence I made pollen culture in cane sugar solutions to ascertain whether there was any possibility of female flowers being fertilized in nature with the pollen from the same inflorescence. At the time I started my studies I had come across only a few exceptions at Akyab where female flowers ripened before the male flowers in the same inflorescence had finished shedding their pollen, but had not seen the paper by Aldaba on the subject, nor did I know of the studies made by Jack and Sands which show that in Malaya self-pollination is the rule rather than the exception. Hence I duplicated many of the results obtained by others. In these studies I obtained the best results with 20% cane-sugar solution, and it was found that every day more and more pollen grains lost their vitality when kept under ordinary conditions till on the seventh day only 3% showed any germination and after that period no grains were seen germinating. Aldaba's ([1]) findings show that in Los Banos, 25 to 30% are the best cane-sugar solutions for effecting germination of pollen grains of the coconut, that pollen remains viable for two to nine days, and that pollen grains from different trees do not maintain their viability for the same length of time.

Now we have seen above that in many places the staminate flowers fall off before the stigmas of the female flowers in the same inflorescence become receptive and it is usual among the planters to argue that where this occurs in-breeding or fertilization by the pollen from the same inflorescence is impossible and that emasculation of the inflorescence of which female flowers only are to be used is unnecessary. That this way of arguing is fallacious is shown by the above results which show that pollen may, under ordinary conditions, retain its vitality even for nine days. Added to this there is the danger of female flowers ripening earlier than usual and, thereby, of their getting self-pollinated, thanks to the reduction of light and warmth caused by the bags used to protect the flowers from foreign pollen; for in the above referred experiments with black paper Van der Wolk ([24]) was able to secure self-pollinated nuts from trees where under ordinary conditions self-pollination was impossible.

When, instead of being kept exposed to ordinary atmospheric conditions, the pollen grains were preserved in celluloid capsules such as are used in administering quinine powder to patients, and the capsules were coated with melted tallow, a greater percentage of pollen grains were found to remain viable. Sampson ([21])

writes in his *Coconut Palm* that coconut pollen can be preserved for several days in hermetically sealed tubes without losing its vitality. But further investigations in this matter are needed so that a system of artificial pollination may be evolved which will insure the rapid improvement of so important a crop as the coconut. It should also be such as to render it easy for planters to know not only the maternity but also the paternity of the seeds chosen. "If pollen grains are wetted," writes Sampson ([21]), "they at once assume a rounded shape and commence to disintegrate within the space of two or three hours. It is thus evident that, in the moist tropical climate which favours the growth of the coconut palm, there is no chance of the shed pollen grains remaining dormant till the female flowers are open and receptive." We have seen that when exposed to ordinary conditions in a laboratory in Singapore pollen remained viable for even seven days. But to test how long the vitality of pollen may remain when it is exposed to an atmosphere saturated with moisture, some was dusted on to a slide kept on a cell and put into a closed petri dish partly filled with water. It was found that had after 6½ hours exposure to such saturated atmosphere the pollen had not lost its vitality, but after 12 hours exposure to such conditions more than 75% of the grains had lost their vitality.

Pollinating Agents.

In most countries, as has been explained above, there is very little chance of the female flowers being fertilized by the pollen from the same inflorescence. This means, therefore, that they have to depend for pollen upon other inflorescences, either from the same tree or from others. The chances of obtaining pollen from an inflorescence on the same tree are very much reduced by the fact that it is only occasionally that a fresh inflorescence opens before the previous one has finished flowering, and this in spite of the vigour and prolificness of some trees. This means that a large number of female flowers have to depend for their pollen on other trees. This explains why in most countries there is so much variation in the seedlings raised from the nuts of the same tree or even from the same inflorescence, when seedlings raised from dwarf coconuts of Malaya where cross-pollination is an occasional chance occurrence behave so like their parent palms ([12]).

Since the stamens and pistils are borne in separate flowers, the pollination in nature can only take place with the pollen brought by winds, or by insects and other creatures that are attracted to them because of their peculiar scent, colour, nectar etc. Knuth ([15]) remarks that the coconut is pollinated through the agency of wind, but quotes Fr. Dahl who noticed the birds *Charmosyna subplacens* Scl., *Cinnyris frenata* S. Mull. and *C. corinna* Salvad. as the frequent visitors of coconut flowers in the Bismarck Archipelago. According to Petch ([18]), pollination is effected chiefly by bees and hornets in Ceylon, though from the structure of the flower, he admits that the wind may be also responsible for the transference to a great

extent. Hunger states that the coconut is pollinated by wind as well as by insects, and among these figure wasp (*wespen*), bee (*begin*), fly (*vliegen*), beetle (*kevers*), and ant (*mieren*). Aldaba (1) working in the Philippines found so little pollen carried by wind from one tree to another that he attaches very little importance to cross-pollination by this agent. The principal insects observed by him as probable pollinating agents are the house fly (*Musca domestica* Linn.) several species of *Lucilia* (Diptera), *Vespa luctuosa* Sauss., *Sarcophaga* sp. *Rhynchium atrum* Sauss., *Apis indica, Trigona biroi* (Hymenoptera) and *Prionecerus caeruleipennis* Perty (Coleoptera). Sampson from the peculiar structure of the flower and the honey glands infers that nature has intended that the coconut flowers should be fertilised by the aid if insects. Burkill (6) has noted *Apis dorsata* and *A. indica* on coconuts in Singapore, but remarks that this genus is often found in the Malay Peninsula on palms overwhelmingly "on male flowers, or on flowers in their male stage, obtaining food without giving what would seem to be an adequate return" and that only *Apis indica* has been seen behaving in that manner in Singapore. The observations of Jack and Sands (12), on the pollination of coconuts in the Malay Peninsula are of unique interest. "In three unopened inflorescences which were bagged in muslin bags, self-pollination was effected naturally and fruits were formed, while in three other inflorescences which were emasculated immediately on opening, no pollination took place and no fruits were formed, though the female flowers behaved normally and although male flowers on adjacent trees were in full bloom. In a similar connection, it has been observed that odd isolated coconut trees growing even under bad conditions produce fruit so that self-pollination must take place. When coconut flowers are in full bloom, at about 10 a.m., when the dew has dried up and when the gentle breezes frequently begin, clouds of pollen can be seen floating away in sunlight. In a very slight breeze these pollen clouds do not travel far owing to the weight of the pollen but it is highly probable that with the strengthening of the breeze as the day advances the pollen clouds are carried to considerable distance and thus cross-pollination is effected." From this it would appear that insects play an unimportant part in the pollination or rather cross-pollination of coconut flowers in the Malay Peninsula. However, as said above, in most countries where coconuts are grown the coconut flowers behave differently. Aldaba's (1) results support the view held by many planters outside the Peninsula that an isolated tree does not bear fruit if male flowers in the succeeding cluster do not shed pollen during the period when the stigmas of the female flowers below are yet in a receptive condition, and that a tree in a grove under the same conditions bears fruit. Jepson (13) who paid a special attention to the insects beneficial or otherwise to coconuts, after saying that pollination of coconuts in Fiji is dependent on wind and insects, among which he noticed bees and some black hymenoptera, attributes the dropping in many districts of Fiji of female flowers in large numbers, resulting in poor yield, to the

great scarcity of insect life in the vicinity of an open inflorescence. He corroborates his view by the observation that, on estates where bees are present in large numbers owing to artificial rearing or otherwise, the yield of nuts is very remarkable high. On these grounds he advises the planters in Fiji to introduce bees on their coconut estates with the view of increasing their crops.

My own studies on this subject have not been very extensive, but they throw some further light on the various points raised by the previous investigators. Regarding the ant as pollintor Petch (18) writes: "In considering the potential insect vistors to flowers in the Tropics one has always to take into consideration the ubiquitous ant. At first sight it seems possible that this insect may take part in the conveyance of pollen from male to the female flower, especially when the periods of the inflorescences overlap. In that case they might convey pollen from one inflorescence to another on the same tree. But it is improbable that they should convey pollen from one tree to another, because the journeys of this species, as a rule, do not extend to two trees.

"There is, however, a special provision on the female flower of the coconut which more or less effectually excludes ants from the work of pollination. The region below the stigma, almost the whole of the area which is exposed when the female flower opens, bears a large number of pores. When the flower is ripe these exude a quantity of moisture which, at least in fine weather, forms a ring of liquid round the stigma and prevents the ants reaching the latter. It is not uncommon to see a crowd of black ants congregated round the edge of this ring. It is probable that, as is usual in cases of this kind, the liquid contains some sugar, so that the ants obtain what they want without robbing the stigma. In any case, it keeps the ants away from the stigma. The position of these water pores can be clearly seen on the young fruit where they are indicated by small whitish spots. These spots owe their colour to masses of minute crystal which are deposited by the liquid."

In the Botanic Gardens, Singapore, I have not found the secretion is in sufficient quantities as to exclude the ant from the stigmas. Hunger has included ants among the pollinators of coconut flowers, and Aldaba admits the possibility of pollination by ants when he presumes the conveyance of pollen by ants as the probable reason for the development of a nut in an emasculated bagged inflorescence. However it may be that the climate of Peradeniya is favourable for the accumulation of the liquid in such large quantities. In places, therefore, like Singapore, where secretion is not in sufficient quantities as to exclude the ant from the work of pollination, it will play an important part particularly with coconuts where male and female flowers ripen together so as to insure self-pollination.

The insects that seem to do yeoman service in pollination or cross-pollination of coconuts in Singapore are some species of *Melipona* (the *dammar* bees), *Apis dorsata,* and some *Muscidae*

principally *Musca* very near *nebulo* (the common, Oriental house-fly), *Lucilia* sp., and *Pycnosoma* sp. These were seen visiting freely both the male and female flowers, though the flies seem to engage themselves more in sipping the honey from the female flowers than in feeding on the pollen or honey in the male flowers. *Apis indica* was a rare visitor to the male flowers, but this bee, according to Burkill, does not give an adequate return for the food it obtains from the flowers of palms. Wasps do not appear so useful as the bees in pollination as they visit the flowers mostly for the purpose of preying on the bees and other insects which are usually beneficial to the pollination of palms. *Vespa cincta* was frequently observed hunting insects and only on one occasion it was observed alighting on male flowers. *Cyrtostomus pectoralis* Hors., was seen but once sipping the honey from the female flowers of a coconut and according to Mr. Chasen of the Raffles Museum, Singapore, *Anthreptes malaccensis* is the sunbird which is almost invariably associated with coconuts in the Malay Peninsula. Various other birds were also seen in the vicinity of coconut inflorescences, but it must be borne in mind that even those birds which possess especial adaptations in their beak for extracting nectar from various kinds of flowers, often visit the flowers for the purpose of capturing insects for their prey and hence the utility of birds in places where there are insects such as bees to pollinate the flowers, is, like that of wasps, doubtful.

My emasculation experiments on dwarf varieties gave results which differ from those obtained by Jack and Sands in the F. M. S. in that I have been able to obtain nuts even though the nearest tree from which pollen could be brought was about 50 yards away from the tree, and though the inflorescences looked sickly and the nectar secretion was reduced because of the injury resulting from the emasculation. Further I have seen nuts developing on those few inflorescences where female flowers became receptive only after the falling of the male flowers. It makes me wonder therefore, whether the failure in F. M. S. to obtain fruit from emasculated inflorescences was not due to the injury resulting from the emasculation or to the absence or scarcity of insect life useful in the pollination of coconut flowers. By keeping unpollinated emasculated inflorescences side by side with the emasculated but artificially pollinated ones it would be possible to throw considerable light on this point.

Influence of Manures.

It is a known fact in horticulture that application of too much nitrogenous manures causes the plants to vegetate at the expense of flowers and fruits, while lime and phosphates tend to divert this energy in the opposite direction, namely to the production of flowers and fruits. Does the same thing occur in coconuts? What manures exert beneficial influence on the flower production in coconuts and what others act detrimentally? Unfortunatelly coconuts have received very little attention in this line from the in-

vestigators and hence our knowledge is at present very limited. We only know that tillage and manures increase the yield and that coconuts require more potash, and probably salt also, than many other fruit crops. However, it must be understood that to study the influence of manures on flower production is not an easy matter in the case of coconuts especially because the immediate effect of manures on estate is often to increase the vegetative growth and to reduce the yield of crops. In making such experiments due consideration has to be given to the fact that the yield in coconuts can be increased in a number of ways, the following being the principal ones:—

1. By the increase in the number of female flowers in each spadix;

2. By causing to grow the spadices that otherwise would have been dormant or abortive;

3. By the rapid production of leaves and inflorescences, due to increase in the number of leaves produced during a given time.

4. By increasing the ability of the ovary to be fertilized even under adverse conditions or increasing the vigour of pollen so that it may be effective in fertilizing the ovum.

5. By reducing the fall of immature nuts due to malt-nutrition of the plant.

All such points have to be considered in a study of the effect of manures before anything can be definitely said about their influence on the production of flowers. Copeland (7) has shown that in the Philippines the leaves take one and a half years from their first appearance until their full development, and that another one and half years are required for fruits to mature in their axils. This period, no doubt, will vary according to the local conditions; but, at any rate it gives us an idea how long the effects of a treatment will last considering that the present treatment will, to a great extent, determine the nature of the embryonic leaves and inflorescences and, therefore, the future crop. Let us assume by way of illustration, that we have started cultivating a very neglected coconut tree. The first effect of this treatment may be that the suppression of many inflorescences and a considerable improvement in the general aspect of the tree. The next symptom of this treatment may be the reduction in dropping of immature nuts, later on the annual number of leaves produced may increase and with them the number of inflorescences, then the number of abortive spadices may gradually be lessened and lastly it may occur that the inflorescences produced may be longer, bearing a greater number of female flowers. Many of these flowers may at first drop because the palms are too weak to produce a sufficient quantity of good pollen. The various changes may not take place in the order mentioned above; but the illustration will, I think, show the necessity of making very careful records for a number of years and herein lies the chief difficulty of experiments. Judging, however, from indirect evidence it can be said that good treatment does increase the

number of inflorescences on a tree and of female flowers in each inflorescences. Many of the villagers' holdings in Goa are situated at the foot of laterite hills, far away from any human habitations and they do not usually receive any attention from their owners. The coconuts trees in such holdings have, as a rule, many spadices aborted, those that are produced have a stunted growth, each bearing ordinarily not more than four or six female flowers; while on holdings which are under a more careful cultivator or near a well or cattle byre the trees produce more spathes and more female flowers in each spadix. Sampson ([21]) is also of opinion that manuring does induce to an appreciable extent, the rapid development of new bunches of flowers, drawing a basis for his assertion from the better behaviour of coconut trees near a dwelling than that of those growing at a distance from where plant food is plentiful in the soil.

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BRANCHED COCONUT PALMS AND THEIR FERTILITY.

Apropos of the note on the *Fertility of Branched Coconut Palms* by Mr. Burkill, published on page 1-2 of Vol. III of this *Bulletin,* the following may not be without interest to readers.

Normally one coconut fruit gives rise to one shoot and this in its turn to one stem. It is not infrequently, however, that one meets with wide deviations from this normal phenomenon. A nut, for instance, may on germination, give rise to more than one shoot, each arising from a separate carpel in the nut. The writer has not come across an instance where a nut had more than two fertile carpels; but it must be remembered that the coconut has a trilocular ovary wherein normally two of the locules become abortive. Cases, therefore, may occur where all three carpels may be stimulated to become fertile as in some species related to *Cocos nucifera.* Forbes reports of "a nut with three cells separated by leathery walls." Sampson ([18]) appears to have seen cases where the septa separating the ovules were hard and not leathery. Forbes, in his article above referred to writes: "I have seen also nuts with cells ranging from four to eight and ten. I send you a rough outline sketch of a tree which has come up from a nut of fourteen cells, all of which germinating, producing a tree with fourteen stems

united at the base." If Forbes' conclusions as to the occurrence of more than three cells in a nut are correct, then the phenomenon concerned might be a case of vegetative multiplication of carpels. If, on the other hand, his conclusions were based merely on the number of shoots that appeared on germination of a nut, then these alternatives are possible (1) that the numerous shoots are due either to the occurrence of polyembryony as in mango, citrus, onion, etc., or (2) to the fasciation of the plumule, or (3) to the monopodial branching with very much abbreviated axis. All these phenomena are loosely described as "branching" although only in the last two cases the true phenomenon of branching occurs. In all other cases, the shoots are distinct individuals, though due to a close adhesion among themselves they may appear to start from single point. The references about the occurrence of polyembryony or more than three carpels in coconuts are not clear, and, therefore, the subject demands further investigations.

The ramification of the main shoot in coconuts is not restricted to the young age only. There are numerous instances where adult coconut palms have branched. The phenomenon concerned in branching palms has been discussed by Mr. Ridley, ([15]) the late Director of the Botanic Gardens, Singapore. He appears to hold the view that true dichotomy never occurs in palms. If this view is correct then the phenomenon of fasciation also never occurs in palms, since fasciation and dichotomy are essentially one and the same phenomenon with the difference that, while in the latter there appears only two shoots, in the former they are always more than two. But the view that true dichotomy never occurs in palms is not absolutely true. Schoute ([17]) has observed the phenomenon of fasciation in stems of some abnormal palms, and that of "true dichotomy of the stem, *as a normal feature*, in *Hyphaene*, an African palm. It (dichotomy) arose as follows: 'The apical meristem ceased to grow, and in place of it, at equal lateral distances therefrom, two new ones appeared.' From this it is obvious that there was no division of the apical meristem into two, and yet true dichotomy is present: because the two lateral branches did not arise owing to injury to the stem-apex; because they are not axillary to any leaves; and because an 'angle-leaf' is present opposite the fork as is the case in dichotomyzing stems of Cryptogams. Moreover, the two branches bore lateral buds in the axils of every leaf. Velenovsky ([17]) has also established by personal observation that true dichotomy occurs in *Chamaedorea Martiana*." Worsdell ([21]) cites a case where the plumule of the palm *Pinanga maculata* in the Kew Gardens, was branched down to the extreme base, the branches being subtended by a common basal sheath. The case was one where it was not easy to decide whether the phenomenon concerned was a true dichotomy or not.

There is another phenomenon which might be confused with the true branching. On the Noakhally Plantation, Akyab, Burma, I was shown plants which were considered as cases of bud-rot and these plants had their central leaves decaying and in some

cases giving disagreable smell. Though a special watch was not kept on the plantation for the disease, yet it was customary to kill and burn all such plants that came to the notice of the manager and spray the neighbouring ones with copper sulphate. It was said that the disease was never seen in the Estate on plants older than ten or twelve years and that the cases were always sporadic, the attacked trees never occurring in groups or bearing any definite relation to the old cases. All this information coupled with my observation of the fact that numerous plants showing similar symptoms, escaped the notice of the man in charge of the plantation and that the disease neither killed these untreated plants nor did it seem to spread from these to the neighbouring trees led me to the conclusion that the trouble in question was other than the suspected bud-rot, genuine cases of which disease I never met on the plantation during my six months stay there. Further observations showed that the pathological condition in most cases could be traced as the consequences of the injury to the palm by the much-prevalent rhinoceros beetles. When the injury to the cabbage reached the apex, the latter was stimulated to change its direction of growth with the result that the young leaves produced previous to this change were starved to death and started to decay. Now the idea that this change of direction of growing apex could be mistaken for true branching would never have occurred to me were it not for the fact, that, through the criticisms by Petch and Gadd, my attention was drawn to such views entertained by Sharples and Lambourne. The former writers have discussed the matter at sufficient length in the *Annals of Botany,* Vol. 37, July 1923, pp. 445-450, and shown that the cases which are considered as genuine cases of lateral branching by the latter (vide *Annals,* Vol. 36, Jan. 1922) are most probably the ones where a change in the direction of growth of the apical bud from vertical to horizontal is involved.

There is yet another phenomenon commonly called "branching", though strictly speaking it is a case which ought to go under the title of chloranthy or proliferation. It consists in the metamorphosis of an inflorescence shoot and usually the trees start producing these abnormal structures when it is of the age to produce normal inflorescences and it continues to produce them till its death. Ridley, ([15]) Petch ([18]) Iyengar ([10]) and Burkill ([2]) have discussed this abnormality in some detail. From the perusal of the literature consulted and from my own observations I am led to conclude that these "bulbils", for so they are termed by Ridley, are never persistent, though Forbes, from his observations made in the Cocos Keeling Islands, was inclined to believe them so. No doubt these outgrowths have usually a much longer life than normal inflorescences, or the leaves of the trees. In one case I observed these abnormal inflorescences grew for more than five years. But even if their life was prolonged for more years I do not think they would give rise to the permanently branched palm, at least the phenomenon concerned would be very different from that of the ordinary ramification in palms. (cf. Burkill's paper).

The peduncle that bears these abnormal structures is essentially of the type of the normal inflorescences: clean, and fibrous for a foot or less from the base, while the structure of the branches from the point of fork is of the type of the stem. The peduncle does not increase in size much more than the peduncle of normal inflorescences, and, like the peduncle of normal inflorescences, has a tendency to form abscisss layer and separate form the main axis. Some of these bulbils bear minute inflorescences consisting of tiny male florets and no female. In the cases observed by me these flowers were borne by secondary shoots produced on the bulbils. The bulbils do not show any tendency to form roots in artificial media ([5]) & ([10]).

Dr. Pulney Andy ([1]) has described a monstrosity which consisted in the phyllody of the greater portion of the female flowers in the spadix, and not of the whole inflorescence itself. Here too "the flower-bud cannot, by such metamorphosis, give rise to ramification in a palm without a true axillary leaf-bud."

Fertility.

In the above discussion it becomes clear that the term "branching" is loosely applied to various phenomena, including some that cannot be classed as branching. And it is possible that the conception that the true branched palms are permanently infertile has orginated from the confusion which exists as to the meaning of the term "branched" coconut palms, that is, by transference to others of the conception derived from some special case or phenomena. Otherwise the prevalence of the idea that the branched palms are permanently unproductive is really unfounded.

I have seen a coconut "branching" at the base bearing fruits; and there are numerous references which show that branched coconuts are not infertile. Morris, ([11]) for instance, reports a fruit in the Kew Museum from a branched coconut tree of the Fiji Islands. According to Scott, ([18]) there was a tree in the vicinity of Calcutta with five fruit-bearing branches. Henry ([8]) makes mention of a coconut tree in the Marquezas Islands, which at the age of eighteen branched into two, both heads starting to bear fruits after two years from the occurrence of the forking. Among these cases there are at least two references which are of interest to Malaya. The frontispiece of the treatise on coconut by Munro and Brown ([12]) is of a coconut tree branching out near the top into five distinct stems, each of which is carrying fruit. The second is of a coconut tree in Penang which had six branches, each of which were "loaded with nuts." ([3]) Apart from these, the *Consols of the East* by Smith and Pape ([20]) and Hunger's *Cocos nucifera* ([9]) have photographs of branched coconut palms bearing fruits. In fact considering the presence of the photographs in the above quoted standard treatises on coconut, one cannot understand the reputed prevalence in Malaya of the view that branched coconut palms are sterile.

By this I do not wish to be understood to say that all truly branched coconut palms are productive. Cases may occur where branched coconuts may not start yielding for a very long period; but in such cases, before one can draw conclusions, it has to be ascertained whether the unproductiveness is due to want of proper care, to the fact that the tree has not yet finished branching, or to some other cause.

A very interesting point in connection with these abnormal palms is to know how their progeny behave and it is very astonishing that nobody has yet tried to solve this question. It is not yet known, for instance, whether seeds of these palms will keep true to the abnormal character or return to the character of the parents to these abnormal ones; whether all of the seeds will do so or only a part of them, and how large a part. In carrying investigations in these lines care has to be taken to prevent cross-fertilisation with the pollen from other plants. This will probably be an easy matter with the dwarf coconuts in Malaya where normally the male and female flowers ripen in a manner as to ensure self-pollination if protected by a bag from foreign pollen. If, however, the inflorescences of these abnormal palms are protandrous, then the female flowers will have to be artificially fertilised with the pollen from the male flowers in the same tree. The branches of palms subject to heavy winds and, therefore, liable to be broken, may be induced to form aerial roots on stems by marcottage and then detached and planted in a place convenient to carry on with the observations. The crown of a palm thus detached has been observed by me to grow when planted out and this practice, it appears, is sometimes resorted to by the gardeners in Malabar, India. (6)

In cases where the inflorescences foliate I have not come across a single reference stating that such trees or their bulbils have borne fruits. In the case described by Dr. Pulney Andy the tree does not produce a perfect fruit. And probably these are the only two phenomena of the ones described above which are infertile. These cases however should not be confused with the ones where coconut fruits, instead of falling when mature and dry, remain on the stalk and under certain conditions germinate on the tree. Guppy (7) saw a case where a seedling thus germinated was about eighteen inches high.

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A CHINESE BELIEF REGARDING PHYLLOCACTUS HOOKERI, WALP.

It is not possible that *Phyllocactus Hookeri,* a Brazilian member of the Cactus family, can be a plant which was treasured in China in the time of the Sung Dynasty (960 to 1278 A. D.); but from information very kindly supplied to the Gardens by Mr. Tan Tang Niah, J. P., President of the Chong Cheng School in Singapore, it seems that in his native Amoy it is now identified with the "Kheng-fa" plant of the Chinese classics.

"The Kheng-fa was held a very precious plant in the time of the Sung dynasty, and there was known but a single individual of it which grew in the Hau-tho-chhi temple in Yang-chow, where, they said, it had been planted during the Tang dynasty (618 to 954 A. D.). Its leaves were by report tender and smooth, with a shining brightness, and its petals thick and pale yellow. Its fragrance was exceptionally sweet. This treasure the emperor Yan-chung, of the Sung dynasty, removed to his forbidden garden, where after a year it showed symptoms of death: but when it was taken back to Yang-chow it revived. Finally during the Chi-yuan years of the Yuan dynasty which followed the Sung dynasty it withered and died. A priest Kam-yu-sui planted in its place a Chu-pat-sin plant; and so during this dynasty what was known as the Kheng-fa was in truth the Chu-pat-sin."

Now, let it be remarked that at the end of the Sung dynasty the chief occupation of the Taoist priesthood in China was a search for medicinal herbs which would bestow immortality: and it is reasonable to consider the above story as connected therewith.

Mr. Tan Tang Niah flowered the plant of *Phyllocactus Hookeri* that he had received from Amoy, in May 1922. Since then others have obtained Phyllocactus plants in Singapore, who offer the flowers as a drug of immense value. In their belief of its value is probably another echo of the long-ago search for a drug bestowing immortality.

A medicinal value of any kind however is extremely questionable; and the repute of it rests in all probability on no more than the plant's slow growth.

I. H. Burkill.

CLEOME CHELIDONII, LINN. F., IN THE MALAY PENINSULA.

In the larger towns of the Malay Peninsula Chinese are to be found who prescribe various fresh herbs to such sick as may consult them; and recently in the shop of one of these in Penang two species of Cleome were detected by Mr. Mohamed Haniff, the owner distinguishing them as "lek tau chhau" and "it tau chhau." The first proved to be *Cleome viscosa,* a plant whose virtues are known in the East. The other proved to be *Cleome chelidonii;*

and a critical examination of the herbarium material preserved in Singapore showed that it is not a new-comer to Penang, for it was collected by Mr. C. Curtis in that island at Pulau Tikus in 1893, and had been obtained previously in 1890 at Prai in Province Wellesley.

Cleome chelidonii occurs in India from the Santal hills, Orissa and Gujarat, southwards, as a weed by no means uncommon. It is found also in Java.

It is possible that it has reached Malaysia by the agency of man: but whether that be so or not, it must now be added to the lists of Malayan plants.

I. H. Burkill.

OBSERVATIONS ON THE EXPANSION OF DICTYOPHORA INDUSIATA, DESV.

Though there are excellent accounts of Phalloids from Ceylon and Java, so that probably nearly all the species are known, very few observations have been made in Malaya, and in the literature at the writer's disposal there is no detailed account of the expansion of *Dictyophora indusiata,* one of the commonest tropical species. Fischer, in his account of the group in Engler's *Pflanzenfamilien* (Teil I, Abt. 1** p. 278), records that the maximum rate of expansion observed was 5mm. in a minute (in Brazil); C. G. Lloyd (*Synopsis of the known Phalloids,* Cincinnati 1909) records an observation of 4 cm. in a minute. The present writer recently had the opportunity of observing the expansion of this species, and the notes made appear to be worth placing on record.

Petch (*Ann. R. Bot. Gard. Peradeniya* Vol. IV pp. 145-151) states that at Peradeniya he could always find specimens fully expanded with the veil still rigid between 8 and 9 a.m., and suggests that expansion probably takes place about 6 a.m., the time of maximum humidity there. Möller in Brazil found expansion to occur between 2 and 7 a.m. In Singapore the time would appear to be as in Ceylon, or occasionally even later. On one occasion fully expanded specimens were found at 8 a.m. but those on which the observations here recorded were made expanded between 8 and 9 a.m.

On May 30th at about 8.15 a.m. my attention was called to three specimens growing on bare ground in a shady place near the Gardens Office. Their condition at this time was as follows:

A. Stalk elongated but veil not yet expanded, the edge just beginning to free itself below the cap.

B. A smaller specimen, in a slightly earlier stage of development, the veil completely hidden by the cap.

C. An unbroken egg.

These were brought into the laboratory and supported in earth under a bell glass. During this operation the edge of the veil of A continued to expand, even though for a few minutes it was lying on the bench. The early stages of expansion were observed in the specimen C, and the later stages in A. and B. C did not properly complete its development. The complete history given in the following paragraph was therefore not observed in a single individual.

After the egg had broken at the apex, the splitting of the volva continued slowly. After about 20 minutes the cap was protruding slightly and the egg was split nearly to the base. Then suddenly the stalk began to expand, growing to a length of about 10 cm. in about 15 seconds. Unfortunately the observer had no time to make an accurate measurement of the time taken in this process, which was exceedingly rapid. Extension continued gradually till about 30 minutes later the total length was about 15 cm. During this period the edge of the veil began to expand slightly from underneath the cap, extending downwards at most 5 cm. Specimen C did not expand beyond this point, the inner surface of the cap not freeing itself properly from the folded veil. In specimens A and B, when the edge of the veil had slightly unfolded, the cap began to move, owing to the further extension of the portion of the stalk above the point of attachment of the veil (hidden by the cap). This extension was from 2 to 3 cm. and in specimen B was complete in two minutes. The extension was accompanied by slight movements of rotation, as if the cap were consciously wriggling to set itself free from the veil. When the extension was complete the folded mass of the veil was completely exposed, and began at once to expand. The unfolding process occupied about 20 minutes in both A and B, the veil reaching down quite to the surface of the soil in which the bases of the eggs were embedded. The total time of expansion was therefore about 70 minutes, possibly as much as 90 minutes, from the breaking of the egg to the complete unfolding of the veil.

The gleba was quite dry when the cap first appeared, and gradually became viscid during the course of expansion. At the same time the veil beneath the cap gradually became separated from it. In specimen C it was observed that in those parts where the under surface of the cap remained adhering to the veil the gleba on the upper surface failed to liquefy; possibly the same source which provides water for the liquefaction of the gleba also causes a wetting and consequent lubrication of the surfaces of contact of the veil and cap, allowing of their separation.

The exceedingly rapid expansion of the fructification is made possible by the mesh structure of the wall of the hollow stalk; the process must be regarded as in the nature of the expansion of a spring which has been placed under pressure and then released. The pressure is presumably due to the turgidity of the cells of the stalk and veil. It is obvious that no further water can be supplied to these cells during the process

of expansion, and it is therefore essential that expansion should take place rapidly and in a humid atmosphere. Under the bell jar the veils remained fairly rigid for three or four hours, and the stalks for 24 hours.

R. E. Holttum.

MOSQUITO LARVAE IN THE PITCHERS OF NEPENTHES.

In the *Journal of the Straits Branch, R. Asiatic Society*, No. 22 p. 430 (1890) Mr. H. N. Ridley published a note stating that he had observed mosquito larvae in the pitchers of *Nepenthes ampullaria* growing in the Gardens Jungle, and that he had reared some of these to maturity in the pitcher. This was probably the first record of such an occurrence. The fact was subsequently confirmed by Mr. Percy Groom (*Annals of Botany* Vol. 7. p. 231). The presence of digestive enzymes in the water contained in the pitchers makes it remarkable that the larvae are able to develop to maturity in such a medium. It is perhaps noteworthy that the pitchers of *N. ampullaria* have a small lid which is bent back, so that more rain water is able to enter than into the pitchers of some other species; this additional water would cause a dilution of the enzymes present. However, Mr. Burkill has observed on Penang Hill that mosquito larvae are easily found in the large lidded pitchers of *Nepenthes albomarginata*. In the paper quoted in the next paragraph there is no reference to the species of Nepenthes concerned.

Since Mr. Ridley's observation there have been numerous similar records, and in a recent number of the *Bulletin of Entomological Research* (Vol. 14 pt. 1 pp. 1-2) Mr. F. W. Edwards gives a list of species of mosquitos which have been found breeding in Nepenthes pitchers in the Oriental Region. Most of the records are from the Malay Peninsula and the total number of species is sixteen. A new record in this paper is the collection of *Megarhinus metallicus* in Nepenthes pitchers on Cameron's Highlands by Dr. H. P. Hacker.

R. E. Holttum.

THE FLORAS OF THE MALAY PENINSULA, BORNEO AND THE PHILIPPINE ISLANDS.

Volumes 1, 2 and 3 of Mr. H. N. Ridley's *Flora of the Malay Peninsula* (London, 1922—1924) have appeared, and volumes 2 and 3 of Mr. E. D. Merrill's *Enumeration of Philippine Flowering Plants* (Manila, 1923). Further the latter's *Bibliographic Index of Bornean plants* (Journal of the Straits Branch of the Royal Asiatic Society, special number, 1921) is available. With these

three a comparison of the natural orders of the Dicotyledons as they occur in the Malay Peninsula, in Borneo, and in the Philippine islands becomes possible; and the following count of the species within them has been made. The sequence of the enumeration is Mr. Ridley's: differences in limits as regards the orders are sufficiently brought out in the column of ordinal names. As the northern end of the Philippines is in the latitude of Calcutta, and the southern in that of Taiping i.e. 5° N., differences are to be expected due to their northward extension, the Peninsula for the purpose of the Flora not going further north than the 7th. degree: also because cultivation has in the Philippines a longer continuous history, they are fuller of weeds than the Peninsula and than Borneo. The total number of Dicotyledons enumerated, for the Malay Peninsula by Mr. Ridley is 4832: by Mr. Merrill for Borneo 3345, and for the Philippine islands 6074. These proportions are nearly 4: 3: 5. Exclude from the Philippine figure the balance over and above the Peninsular figure and the remainder may be regarded as the true Malaysian Flora, which spreads through the three with genera in general in common, but species diverse. Its focus is in Borneo, where the Dipterocarpaceae and Nepenthaceae are in the largest numbers. But the low total of 3345 for Borneo is an indication of a very large amount of collecting yet to be done in that island. In the list clarendon type and italics are used to call attention to totals which are widely in excess or deficit of the proportion 4: 3: 5. The result is that:—

1. In the Malay Peninsula 22 orders have more than their proportion of species:—Violaceae, Flacourtiaceae, Guttiferae, Olacaceae, Celastraceae, Staphyleaceae, Anacardiaceae, Connaraceae, Hamamelidaceae, Anisophyllaceae, Combretaceae, Cornaceae, Ebenaceae, Asclepiadaceae, Apocynaceae, Loganiaceae, Scrophulariaceae, Lentibulariaceae, Acanthaceae, Lauraceae, Proteaceae, and Santalaceae:

2. In Borneo the following 18 have more than their proportion of species:—Dilleniaceae, Menispermaceae, Hypericaceae, Dipterocarpaceae, Gonostylaceae, Linaceae, Ochnaceae, Ilicaceae, Ampelidaceae, Melastomataceae, Cucurbitaceae, Ericaceae, Epacridaceae, Sapotaceae, Rafflesiaceae, Nepenthaceae, Casuarinaceae and Cupuliferae:

3. The Philippine islands have more than their proportion of the following 30:—Ranunculaceae, Anonaceae, Berberidaceae, Pittosporaceae, Malpighiaceae, Balsaminaceae, Rutaceae, Simarubaceae, Burseraceae, Meliaceae, Sapindaceae, Rosaceae, Saxifragaceae, Samydaceae, Begoniaceae, Araliaceae, Compositae, Lobeliaceae, Vacciniaceae, Primulaceae, Boraginaceae, Solanaceae, Labiatae, Polygonaceae, Piperaceae, Monimiaceae, Hernandiaceae, Thymelaeaceae, Loranthaceae and the Urticeae of the Urticaceae.

In the following five orders, which are proportionally most numerous in Borneo, the Philippine islands are relatively poorer than the Malay Peninsula:—Dilleniaceae, Dipterocarpaceae, Ochn-

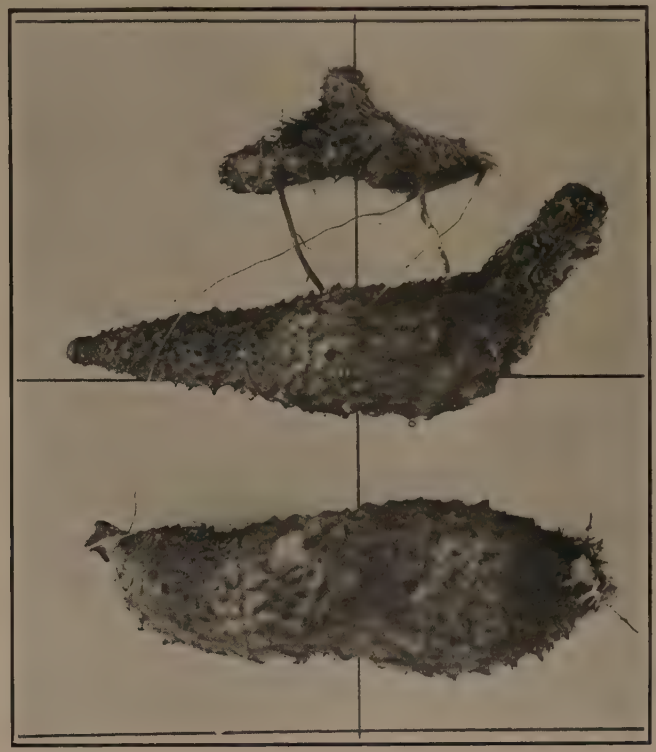
aceae, Nepenthaceae, and Cupuliferae: whereas in only the numerically small Gonostylaceae is the Malay Peninsula relatively poorer than the Philippine islands. These are indications of the closer affinity, well known, of the flora of Borneo to that of the Malay Peninsula than to that of the Philippines.

		Malay Peninsula.	Borneo.	Philippine Islands.	
1.	Ranunculaceae	*3*	4	**12**	Some Northern types in P. I.
2.	Dilleniaceae without Saurauia	25	**30**	18	
3.	Magnoliaceae	11	4	10	
4.	Winteraceae	2	2	3	
5.	Schizandraceae	3	1	5	
6.	Anonaceae	81	54	**144**	
7.	Menispermaceae	26	**26**	35	
8.	Berberidaceae	0	0	**2**	northern influence
9.	Nymphaeaceae	6	3	*3*	Barclaya absent from P. I.
10.	Papaveraceae	0	0	1	weed
11.	Cruciferae	1	0	5	weeds
12.	Capparidaceae	16	*5*	24	several weeds
13.	Violaceae	**21**	9	18	Alsodeia week, but Viola strong in P. I.
14.	Pittosporaceae	2	1	**15**	Pittosporum strong in P. I.
15.	Polygalaceae	33	25	*22*	M. P. strong in Xanthophyllum
16.	Caryophyllaceae	1	0	9	several weeds
17.	Portulacaceae	2	1	4	
18.	Hypericaceae	6	**7**	7	
19.	Flacourtiaceae without Samydaceae	**24**	7	19	
20.	Guttiferae without Hypericum	**73**	47	60	
21.	Ternstroemiaceae with Saurauia	*40*	50	81	Saurauia strong in P. I.
22.	Dipterocarpaceae	89	**103**	*50*	
23.	Ancistrocladaceae	1	0	0	
24.	Elatinaceae	0	0	2	
25.	Bixaceae	1	1	1	
26.	Malvaceae with Bombacaceae	*29*	35	54	
27.	Sterculiaceae	53	37	57	
28.	Tiliaceae with Elaeocarpaceae	73	*41*	97	Pentace not in B.

		Malay Peninsula.	Borneo.	Philippine Islands.	
29.	Gonostylaceae	*1*	**5**	4	
30.	Linaceae with Erythroxylaceae	5	**7**	6	
31.	Malpighiaceae	5	4	**17**	
32.	Zygophyllaceae	0	0	1	weed
33.	Geraniaceae	0	0	1	weed
34.	Oxalidaceae	16	10	7	
35.	Balsaminaceae	14	6	**25**	
36.	Rutaceae	44	*19*	**83**	northern influence in P. I.
37.	Simarubaceae	8	3	**15**	
38.	Ochnaceae	8	**19**	*6*	
39.	Burseraceae	30	24	**56**	Canarium strong in P. I.
40.	Meliaceae	87	*52*	137	Dysoxylum and Aglaia strong in P. I.
41.	Chailletiaceae	8	*2*	13	
42.	Olacaceae with Icacinaceae	39	24	*38*	
43.	Ilicaceae	17	**16**	21	
44.	Celastraceae	**50**	*14*	45	
45.	Stackhousiaceae	0	0	1	
46.	Rhamnaceae	20	*5*	27	B. has but one sp. of 5 genera
47.	Ampelidaceae	50	**45**	67	
48.	Sapindaceae with Aceraceae	56	49	**127**	
49.	Staphyleaceae	3	1	1	
50.	Sabiaceae	10	8	18	
51.	Anacardiaceae	**72**	34	50	Mangifera strong in M. P.
52.	Coriariaceae	0	0	1	
53.	Moringaceae	0	0	1	introduced
54.	Connaraceae	**27**	14	27	
55.	Leguminosae	*261*	174	*248*	
56.	Rosaceae	*37*	24	**59**	a northern element in P. I.
57.	Saxifragaceae	15	8	34	a northern and montane element in. P. I.
58.	Droseraceae	2	3	4	
59.	Crassulaceae	1	1	4	
60.	Hamamelidaceae	**5**	0	2	
61.	Halorrhagidaceae	*0*	2	6	
62.	Rhizophoraceae	8	8	8	

		Malay Peninsula.	Borneo.	Philippine Islands.	
63.	Legnotidaceae	10	9	8	
64.	Anisophyllaeaceae	**6**	3	*0*	
65.	Combretaceae	**23**	11	*21*	
66.	Myrtaceae	149	122	199	
67.	Melastomataceae	174	**171**	234	
68.	Lythraceae, with Sonneratiaceae and Crypteroniaceae	14	7	19	
69.	Punicaceae	(1)	0	1	
70.	Onagraceae	7	4	8	
71.	Samydaceae	20	15	**35**	
72.	Turneraceae	2	1	*0*	
73.	Passifloraceae	9	6	9	
74.	Cucurbitaceae	23	**28**	34	
75.	Caricaceae	1	1	1	
76.	Begoniaceae	34	26	**89**	Begonia strong in P. I.
77.	Datiscaceae	1	1	1	
78.	Cactaceae	1	0	5	introduced american plants
79.	Aizoaceae	3	1	5	
80.	Umbelliferae	6	5	11	
81.	Araliaceae	48	*22*	**105**	Boerlagiodendron & Schefflera strong in P. I.
82.	Cornaceae, with Alangiaceae	**17**	7	*5*	
83.	Caprifoliaceae	5	4	11	
84.	Rubiaceae	466	333	529	
85.	Compositae	45	38	**142**	a northern element in P. I.
86.	Stylidiaceae	1	0	1	
87.	Goodeniaceae	*1*	2	8	
88.	Lobeliaceae	2	1	6	
89.	Campanulaceae without Lobeliaceae	6	4	9	
90.	Vacciniaceae	20	17	**37**	Vaccinium strong in P. I.
91.	Ericaceae, with Clethraceae	33	**55**	36	Rhododendron strong in B.
92.	Monotropaceae	1	0	0	
93.	Epacridaceae	1	**4**	1	
94.	Primulaceae	0	0	**6**	northern element in P. I.
95.	Plumbaginaceae	1	0	3	
96.	Plantaginaceae	1	1	2	

		Malay Peninsula.	Borneo.	Philippine Islands	
97.	Myrsinaceae	95	81	141	
98.	Sapotaceae	61	**57**	69	
99.	Ebenaceae	**50**	29	*37*	
100.	Styracaceae with Symplocaceae	35	25	42	
101.	Oleaceae	28	20	33	
102.	Apocynaceae	**120**	71	95	
103.	Asclepiadaceae	**112**	*48*	113	
104.	Loganiaceae	**54**	30	*45*	Gaertnera is absent from P. I.
105.	Gentianaceae	10	*5*	15	
106.	Hydrophyllaceae	1	0	1	
107.	Boraginaceae	11	*3*	**23**	
108.	Convolvulaceae	24	*26*	59	
109.	Cardiopteridaceae	2	1	1	
110.	Solanaceae	18	11	**38**	several introduced plants in P. I.
111.	Scrophulariaceae	**44**	26	45	
112.	Orobanchaceae	2	1	2	
113.	Lentibulariaceae	**15**	7	9	
114.	Gesneraceae	161	112	*135*	Didymocarpus strong in M. P.
115.	Bignoniaceae	10	*3*	19	
116.	Pedaliaceae	1	1	1	
117.	Acanthaceae	**168**	*51*	129	
118.	Verbenaceae	75	47	105	
119.	Labiatae	30	19	**60**	Coleus strong in P. I.
120.	Nyctaginaceae	4	0	8	some introdecued plants in P. I list
121.	Amarantaceae	15	10	22	weeds or of rather N. type
122.	Chenopodiaceae	0	0	3	northern type
123.	Basellaceae	(1)	0	2	introduced plants
124.	Phytolaccaceae	0	0	1	introduced plants
125.	Polygonaceae	9	7	**23**	'horthern element in P.I.
126.	Aristolochiaceae	10	6	13	
127.	Rafflesiaceae	2	**6**	2	Rafflesia only
128.	Nepenthaceae	10	**26**	*9*	Nepenthes only
129.	Piperaceae	83	*36*	**137**	Piper strong in P. I.
130.	Saururaceae	0	0	1	a rather northern and pacific type
131.	Chloranthaceae	2	2	6	
132.	Myristicaceae	45	37	*40*	



"TUBERS OF A STENOMERIS"

		Malay Peninsula.	Borneo.	Philippine Islands.	
133.	Monimiaceae	4	5	**17**	
134.	Lauraceae	**175**	74	*110*	
135.	Hernandiaceae	4	*1*	9	
136.	Proteaceae	**10**	3	*8*	
137.	Thymelaeaceae	*9*	9	**24**	Wikstroemia strong in P. I.
138.	Elaeagnaceae	1	0	1	
139.	Loranthaceae	*46*	47	**101**	Loranthus strong in P. I.
140.	Santalaceae	**14**	6	5	
141.	Opiliaceae	4	1	5	
142.	Balanophoraceae	6	4	5	
143.	Euphorbiaceae	**351**	*195*	385	
144.	Urticaceae				
	Celtideae or Ulmaceae	8	7	13	
	Moreae	*127*	116	203	
	Urticeae	*26*	46	**151**	Elatostema strong in P. I.
145.	Juglandaceae	3	1	5	Engelhardtia only
146.	Myricaceae	2	2	3	
147.	Casuarinaceae	1	**3**	3	
148.	Cupuliferae	51	**48**	*41*	
149.	Salicaceae	1	—	1	not native in M. P.
150.	Ceratophyllaceae	—	—	1	
		4832	3345	6074	

I. H. Burkill.

STENOMERIS IN THE MALAY PENINSULA.

In 1896, at Gua Batu or Batu Caves, not far from Kuala Lumpur, Mr. H. N. Ridley obtained a scrap of a *Stenomeris* in flower. This scrap he referred to *Stenomeris borneensis*, Oliv., in his *Materials for a Flora of the Malay Peninsula, Monocotyledons*, 2, 1907, p. 85, adding a remark to indicate that he had not material enough to be quite positive of its identity with the Bornean plant so named.

In March, 1922, the writer found sterile in the Bukit Raja forest a Dioscoreaceous plant which is considered to be the species found by Mr. Ridley; and in foliage it agrees with *S. borneensis* as figured in Hooker's *Icones Plantarum*, plate 2328. Its locality was visited again in Oct. 1922, Jan. 1923, Dec. 1923, and Sept. 1924,

without success in finding flowers, and it has been seen sterile at the 11th mile on the Kuala Lumpur—Klang road. It was found again in great abundance in the Pondok Tanjong forest reserve, Perak, sterile, in March 1924. It is disappointing that so far these attempts to make sure of the species have failed.

Its underground tubers are small, and horizontal—they are figured upon the adjoining plate from specimens dug up near Klang. Each consists of two or three internodes of stem tissue, swollen, and covered with weak processes of parenchymatous cells. In the plate the scars of the bracts at the nodes are clearly visible; and their presence is important in that we have by their means proof of the compound stem-nature of the tuber, an observation bearing on the disputed morphology of the underground parts in the allied genus *Dioscorea*.

The tubers of the Stenomeris are seen to be formed laterally as branches upon the white half-translucent underground part of the stem. They grow to a length of 2 to 3 inches and themselves give rise, as is seen in the lowest of the five tubers in the left hand half of the plate, to a new half-translucent stem—not from their tip but laterally. It is clear from the plate that this lateral production is a normal event: and it indicates the tubers as resting branches, suggesting that bulbil formation in Dioscorea may likewise be called the production of resting branches: or the tubers of this Stenomeris might equally be called underground bulbils without much misuse of the word "bulbil." It is interesting, apart from this, that renewed growth is lateral.

The interior of the tuber contains starch, of which only a little was seen; but as it was examined when the stems were in new and vigorous growth, the smallness of the amount is not surprising.

I. H. Burkill.

A NOTE ON SEMECARPUS CURTISII, KING.

It was pointed out to me by Mr. Burkill that in the specimens placed under *Semecarpus Curtisii*, King, in the Singapore Herbarium, there was a difference between those from the North and those from the South of the Peninsula. On examination, it was found that there was a distinct difference, almost enough to admit of a new species being erected, had there not been one plant (Ridley 10566, from Ulu Selangor) which was intermediate between the two forms both in locality and in character.

Semecarpus Curtisii, *King,*

Curtis 2930, type! Puket, Tongkah, Siam.
Burkill & Md. Haniff, 13318! Alor Star, Kedah
Ridley, 15186! Setul.
Annandale ! Kaw Suan Toon, Siam.
Ridley 10566! Ulu Selangor.

Semecarpus Curtisii, *King*, var. **brevipetiolata**, n.v.

Holttum 9521! Gunong Tampin, Negri Sembilan.
Alvins 885! Gaong Jalan, Negri Sembilan (or Malacca).
Burkill, 3230! Gunong Tampin, N. S.
Md. Nur, 1623! Bukit Kayu Arang, Tampin, N. S.

differs from typical *Curtisii* in the shorter petioles, which are 1.3 to 2 cm. long, in the glabrous disc of the male flower, and in the absence of white scales on the under side of the leaf, and in the slightly more pubescent panicle, though this is variable.

Ridley 10566 from Ulu Selangor, which I have put into typical *Curtisii*, seems to approach the var. *brevipetiolata* in the pubescence on the panicle, and in the absence of white scales on the under surface of the leaf, but it has a long and not a short petiole. The specimen, however, is a poor one.

Semecarpus Prainii, *King*

Md. Haniff & Md. Nur 3938! Pungah, Lower Siam.
Kunstler 7442! Larut, Perak.

This species has been omitted from Ridley's Flora of the Malay Peninsula.

M. R. Henderson.

NEW RECORDS OF SPECIES OF LYCOPODIUM FROM THE MALAY PENINSULA.

Since the publication of Mr. Ridley's "List of the Fern Allies and Characeae of the Malay Peninsula" (*Journ. S. B., R. Asiatic Society* No. 80, 1919, p. 139) the following species of Lycopodium not there recorded have been collected.

L. clavatum L. var. *divaricatum* (Wall.) This species is cosmopolitan, and the variety *divaricatum* has been found on mountains at various localities from the Himalayas through Malaysia to the Philippines. It was collected apparently for the first time in the Malay Peninsula below Fraser Hill, at an altitude of about 3860 feet, in an open place in a valley which had formerly been cleared for tin mining. (Gardens No. 11303).

L. verticillatum L. fil. Collected by M. R. Henderson at Robinson Falls, Cameron's Highlands, Pahang, 4800 feet. (F. M. S. Museums No. 11730). Distribution: Java and Borneo to Polynesia, Trop. America. South and East Africa, Mascarenes.

L. hippuris Desv. A living plant collected on Gunong Pulai, Johore, in June 1922, by G. A. Best, has since been in cultivation in the Gardens, and is freely fertile; it appears to belong to this species. Unnamed specimens in the Herbarium from Singapore (Sungei Sembawang, Ridley no. 6520) and the Taiping Hills (Long) agree with it. Distribution: Java and the Philippines to Samoa.

R. E. Holttum.

ORCHID NOTES

Oberonia fungum-olens,—a new Species.

In June 1924 an Oberonia was found in some plenty at the foot of the Main range of the Peninsula near Tanjong Malim, which in cultivation in Singapore produced flowers freely in September: it proves to be a species new to the Peninsula and appears to be undescribed. It is here named *O. fungum-olens* from the smell of its flowers being just such as is given out by species of *Fomes* and other similar fungi. The colour of these small but numerous flowers is likewise suggestive of these fungi.

Its affinity is with *O. anceps,* Lindl. and *O. spathulata,* Lindl. which are found rather widely in Eastern Malaysia. Ridley remarks of *O. anceps* that it is "the largest native species" (Mat. Fl. Mal. Penins. Monocots., I, 1908, p. 18); but this new one is larger: so also is *O. spathulata,* which was unrecorded for the Peninsula in 1908.

Flower of *Oberonia fungum-olens*, x 5.

Oberonia fungum-olens.

Caules dependentes, numerosissimi, 10—20 cm. longi, compressi, c. 15-foliati, cum foliis ad 2 cm. lati, internodiis 1 cm. longis vel paullulo longioribus. Folia alternatim bifaria, basi dimidio imbricantia, lateraliter admodum compressa, carina dorsale paullulo incurvata ad 4 cm. longa, marginibus subrectis vix 3 cm. longis, viridissima. Inflorescentia subsessilis, densiuscula, cylindrica, multiflora, ad 12 cm. longa, floribus forsan ad 300, basalibus spiraliter apicalibus verticillatim dispositis, istis serotinis. Rhachis scarioso-puberula, viridi-fuscescens aliquo modo profunde striata, striis tot quot floribus in verticillis. Flores melleo-fusci, fungum-olentes, aperti sepalo dorsale excepto plani, versus folia id est versus coelum respicientes. Sepalum dorsale suborbiculare, c. .75 mm. diametro, extus minutissime puberulum. Sepala lateralia late ovata, vix 1 mm. longa, apice obtusa, .5 mm. lata. Petala elliptica, obtusa .75 mm. longa. Labellum supra curvatum, basi excavatum; auriculae basales erectae, apice rotundatae, facie minutissime pustulatae, vix 1 mm. longae: lobi duo, irregulare subquadrato-rotundati, 1.5 mm. longi et lati. Gynostemium viride, ambitu triangulari-rotundatum.

Planta epiphytica, ex vivo in Horto Botanico Singapurensi descripta. Origo ejusdem in pede montium prope vicum Tanjong Malim principalii Perak.

A comparison of Coelogyne celebica and C. speciosa.

Coelogyne celebica, J. J. Sm., has recently flowered in the Botanic Gardens, Singapore, at the same time as *C. speciosa* Lindl.; and the opportunity was taken of figuring the flowers of the two side by side. The origin of *C. celebica* was Paloppo in the Island of Celebes; and the origin of *C. speciosa* the Taiping Hills, in the Malay Peninsula.

The first figures below (1 and 1a) are of the flowers of the two seen from above, drawn to show how the petals of *C. celebica* during the course of the life of the flower recurve so that their tips meet, whereas the petals of *C. speciosa* do not do so. The dorsal sepal in *C. celebica* is seen to be narrower than that of *C. speciosa*.

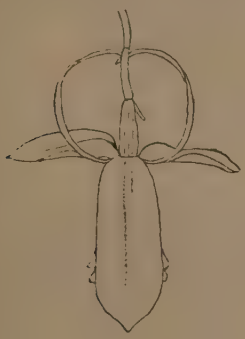


Fig. 1.

Fig. 1a.

Flowers of *Coelogyne celebica* (left) and *C. speciosa* (right) from above, x ½.

In the next pair of drawings (2 and 2a) it is shown that the dorsal sepal rises up in *C. celebica* a little more than in *C. speciosa*. The tip of the lip in both is equally curved backwards and cannot be seen in face view in either.

Fig. 2.

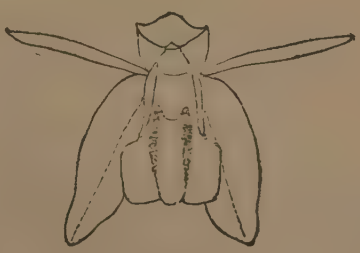


Fig. 2a.

Flowers of *Coelogyne celebica* (left) and *C. speciosa* (right) from in front, x ½.

There is a slight difference in the gynostemia of the two, as the following pair of drawings show (3 and 3a).

Fig. 3. Fig. 3a.

Gynostemium of *C. celebica* (left) and *C. speciosa* (right), × ½

There is a very great difference in the crests of the lip. The crest in *C. speciosa* (4a) is continuous with much sinuation: the crest in *C. celebica* (4) is toothed.

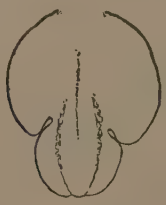
Fig. 4.

Fig. 4a.

Crests of the lips of *C. celebica* (above), and *C. speciosa* (below), × ½.

The lip of *C. celebica* is marbled with a rich brown: that of *C. speciosa* with purplish black. The rest of the flower of *C. celebica* is yellower than that of *C. speciosa*, wherein there is just the faintest suggestion of the salmon tint found in other species of its genus.

Fig. 5.



Lip of *C. celebica* flattened, ½ nat. size.

Fig. 5 shows the lip of *C. celebica* flattened out.

All figures are half natural size.

Dendrobium albicolor Ridl., in Pénang.

In the Waterfall valley, Penang, upon a mango tree at a small distance from the gates of the Waterfall Gardens, the above named species of Dendrobium has been found. It was described in the Journal of the Linnean Society of London, 32, (1896) p. 250, upon specimens obtained by Mr. C. Curtis at Pungah in Lower Siam: and it is possible that he placed it upon the mango tree near to the Gardens, or it is possible that it has been carried by some nesting bird from the Gardens. The annexed drawings illustrate

the flower, which lacks the red spots described in Mr. Ridley's definition.

It is now in great abundance upon the tree.

Fig. 1.

Fig. 2.

Fig. 3.

(1) Branch of Dendrobium albicolor X ½

(2) Flower in face view, nat. size.

(3) The upper half of the flower and the lip flattened, nat. size.

Dendrobium Haniffii, Ridley.

Dendrobium Haniffii was obtained by Mr. Mohamed Haniff in Kelantan upon the Lebir river, always on branches overhanging the water. It is an epiphyte, with green stem up to 40 cm. long, slightly swollen upwards. The leaves are about 10 cm. long by 1.5 cm. wide. The flowers are many in well-grown plants: their

A flower of *Dendrobium Haniffii*, ½ nat. size.

predominant colour is a very pale pinkish lilac, the sepals and lateral petals being uniformly thin. These are 4.5 to 5cm. long or a trifle longer; the sepals 7 mm. wide; the lateral petals at the middle 12 mm. wide. The dorsal sepal is twisted on itself as drawn: the lateral sepals, also—all in the same direction: but one of the latter seems to have less tendency in its lower half to twist than its partner. The spur is only 5 mm. long and dull yellow. The lip is folded on itself making a tube 1 cm. long, and in the 1.5 cm. above open upwards and forwards. If laid open entirely, it is as drawn, and is seen to have magenta marks at the base on either side in the positions indicated. There is also a very faint shade of magenta in lines on it.

The lip of *Dendrobium Hanifii*, n. t. size.

The cap of the anther is magenta: the column below green passing into the dull yellow of the interior of the spur. Pollen masses are sessile.

I. H. Burkill.

RAINFALL at the Botanic Gardens, Singapore, during the first half of the year, 1923. Readings taken at 9 a.m. and expressed in inches.

Date	Jan.	Feb.	March	April	May	June
1	.68	—	—	.61	—	1.41
2	.53	—	—	—	—	.87
3	.25	—	—	.19	—	.53
4	trace	trace	.05	1.09	.12	.02
5	.14	—	.07	—	—	—
6	.15	—	.90	—	—	1.25
7	1.88	—	—	—	—	—
8	.71	—	—	—	trace	.03
9	.24	—	—	.01	.64	—
10	.42	.01	—	.06	.10	—
11	.03	—	.63	—	—	—
12	.08	—	—	—	—	.01
13	1.81	—	.01	—	.17	.78
14	—	.36	1.49	1.21	—	.01
15	.43	—	1.52	trace	—	.41
16	—	—	trace	—	—	.34
17	.51	.02	.06	—	.01	—
18	.59	1.28	.18	—	—	—
19	.03	trace	—	.74	—	—
20	—	—	—	—	.19	—
21	1.28	—	—	.35	1.38	—
22	.22	.01	—	.03	.25	—
23	.62	—	.23	.19	.03	.89
24	—	.01	.08	.12	—	trace
25	—	.02	.16	.46	.29	—
26	—	—	.39	.02	.25	.55
27	trace	—	—	.03	trace	.03
28	—	—	—	—	trace	.10
29	—		—	—	3.12	.04
30	—		—	—	.01	—
31	.01		1.40		.46	
Total	10.61	1.71	7.17	5.11	7.02	7.27

RAINFALL at the Botanic Gardens, Singapore, during the second half of the year 1923. Readings taken at 9 a.m. and expressed in inches.

Date	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	—	—	—	—	1.23	.46
2	—	—	—	.11	2.17	.73
3	.50	—	—	.04	.02	.56
4	.11	.01	.01	—	—	.26
5	—	—	—	trace	.03	.01
6	.14	—	.16	—	.84	—
7	.46	.63	—	—	.03	1.21
8	trace	—	.01	—	—	.02
9	.03	—	.19	.27	.11	—
10	2.08	.88	—	—	.24	.63
11	.95	.23	.01	.16	.44	—
12	.03	.08	.01	.07	.38	.46
13	.03	—	.02	.01	.01	1.00
14	—	.19	.02	—	—	.03
15	.32	—	.02	—	.07	.21
16	.36	.75	2.87	.35	—	.14
17	—	—	.16	.23	—	.07
18	1.06	.68	—	—	—	.01
19	.02	.08	—	—	—	.66
20	—	—	.79	—	—	.24
21	.21	—	—	.45	—	.01
22	trace	.02	.19	.21	—	—
23	.10	.64	—	—	.06	.12
24	trace	.07	.61	.09	.89	1.64
25	.01	—	.50	.35	.09	trace
26	3.34	—	trace	.11	1.96	—
27	.19	1.19	—	.09	.19	—
28	—	—	.01	—	.41	.07
29	—	trace	—	.04	.02	—
30	—	.12	—	—	.09	.29
31	.31	.36		trace		.07
Total	10.25	5.93	5.58	2.58	9.28	8.90

RAINFALL at the head of the Waterfall Gardens, Penang, during the first half of the year 1923, in inches.

Reading taken at 8 a.m. and credited to the date in which the twenty-four hours begin. Data kindly supplied by the Municipal Commissioners of George Town, Penang.

Date	Jan.	Feb.	March	April	May	June
1	—	—	—	.08	.07	.49
2	.52	—	—	.30	.39	—
3	.07	—	—	—	—	1.35
4	—	—	—	—	—	.90
5	—	—	.72	1.25	—	.02
6	.05	—	—	.23	.36	—
7	—	—	—	—	—	—
8	.38	—	.83	—	.19	.31
9	.34	—	1.60	1.17	.89	—
10	.28	—	.33	.03	1.15	—
11	—	—	.02	.05	.27	—
12	—	—	—	.26	.18	—
13	.24	—	—	.03	.20	2.20
14	—	.03	.06	—	.10	.63
15	—	.02	.20	.27	.77	1.79
16	—	—	.07	—	3.24	.87
17	—	2.06	.08	—	.78	—
18	.04	—	—	—	—	—
19	1.73	—	.07	.09	.47	—
20	.03	.04	—	—	.32	—
21	.08	1.27	—	.04	.02	—
22	.49	—	—	1.16	—	.30
23	—	—	—	.09	—	3.84
24	—	—	.20	1.82	.12	.30
25	—	—	—	1.16	1.25	.03
26	—	—	1.53	—	—	—
27	—	—	1.10	—	.65	.19
28	—	.02	—	—	.30	.05
29	—		.05	—	1.78	.94
30	—		—	—	.10	2.85
31	—		—		.05	
Total	4.25	3.44	6.86	8.03	13.65	17.06

RAINFALL at the head of the Waterfall Gardens, Penang, during the second half of the year 1923, in inches.

Reading taken at 8 a.m. and credited to the date in which the twenty-four hours begin. Data kindly supplied by the Municipal Commissioners of George Town, Penang.

Date	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	—	—	.29	.53	—	—
2	.03	—	.72	4.62	.01	—
3	2.15	—	—	2.86	1.85	—
4	—	.24	—	—	—	.19
5	—	—	.07	.96	.50	.01
6	.30	1.66	.17	.24	.04	—
7	.22	.10	.68	.34	.05	—
8	.02	—	2.70	1.29	.78	.05
9	—	2.36	.27	.37	5.31	.14
10	1.38	.18	2.12	2.24	2.25	1.82
11	1.13	1.47	7.90	1.19	.48	—
12	—	.11	1.15	.11	.05	.05
13	.54	—	.04	.95	.11	.37
14	—	.07	.72	.05	—	.03
15	—	—	.57	.24	.13	.04
16	—	—	1.38	.05	.07	.50
17	—	—	.48	.26	2.16	—
18	.90	.10	—	.26	.47	.03
19	.92	.28	1.55	.03	.03	.57
20	—	—	.13	1.43	.48	.68
21	.28	.39	.55	.07	.61	.03
22	—	.64	—	.07	—	—
23	—	.78	—	.34	.41	—
24	—	.55	.23	2.05	2.30	—
25	—	.15	2.74	.33	—	—
26	—	—	2.30	1.09	—	—
27	—	—	—	1.40	.19	.83
28	.40	.56	—	3.42	—	—
29	—	.23	1.63	1.78	1.33	—
30	—	.26	—	1.83	.79	—
31	—	.03		.62		—
Total	8.27	10.16	28.39	31.02	20.40	5.34

Relative Humidity of the air at the Botanic Gardens Singapore, calculated from wet and dry bulb hygrometer readings made daily at 9 a.m. during the year 1923.

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	100	80	72	81	78	100	85	79	83	83	93	98
2	95	100	85	79	78	87	80	83	79	81	78	91
3	98	78	81	79	78	83	98	85	83	83	89	100
4	90	80	98	81	78	81	79	83	81	78	78	93
5	84	78	83	80	80	84	89	79	79	76	93	79
6	97	84	82	78	80	81	84	83	81	76	100	78
7	98	76	81	77	80	81	95	93	78	76	87	82
8	98	74	75	69	89	89	87	81	78	87	87	76
9	86	71	85	87	100	83	91	87	79	83	91	93
10	83	76	83	76	81	81	98	86	79	76	81	75
11	98	78	83	85	81	87	98	100	81	91	95	79
12	89	77	85	81	79	78	77	83	83	89	91	89
13	87	79	83	83	89	100	89	83	79	76	78	89
14	86	85	81	85	83	85	83	100	95	78	85	87
15	80	85	79	87	77	100	67	83	79	89	85	100
16	86	85	81	79	81	84	91	85	97	79	78	87
17	87	81	76	78	83	83	79	83	81	76	78	87
18	91	88	77	75	78	83	91	100	83	66	80	95
19	85	81	77	85	80	81	78	83	81	76	74	95
20	79	77	77	93	91	80	83	81	81	74	79	91
21	91	85	79	85	78	80	84	85	82	70	75	77
22	83	80	79	80	93	82	81	83	87	78	81	79
23	81	83	79	98	85	93	83	100	81	73	81	83
24	82	83	79	81	76	89	89	79	89	95	72	89
25	79	72	83	89	100	81	85	83	82	74	76	81
26	72	83	79	85	81	100	100	85	81	89	76	83
27	80	81	79	76	93	85	83	83	87	76	76	72
28	82	79	87	85	76	100	81	83	85	73	95	78
29	78		83	—	100	83	83	83	81	78	74	79
30	78		78	79	87	80	81	100	76	76	93	80
31	76		83		95		83	81		72		81
Average	86	81	81	82	84	86	86	89	82	79	83	85

Average for the year 83.8.

SUMMARY OF RAINFALL 1923.

	SINGAPORE.				PENANG.			
	No. of rainy days	Amount of rain in inches	mm.	Longest Spell without rain	No. of rainy days	Amount of rain in inches	mm.	Longest Spell without rain
January ...	22	10 61	270	3 days	12	4.25	108	9 } 22 days
February ...	9	1.71	42	5*	6	3.44	87	13 }
March ...	15	7.17	185	4	14	6.86	174	4
April ...	15	5 11	130	4	16	8.03	204	6
May ...	17	7.02	178	3	23	13.65	346	3
June ...	17	7 27	184	6	17	17.06	433	5
July ...	22	10.25	260	3	12	8 27	210	6
August ...	16	5 93	150	3	19	10.16	258	3
September ...	17	5.58	142	3	22	28 39	721	2
October ...	17	2.58	66	3	30	31.02	788	1
November ...	20	9.28	235	7	23	20.40	518	2
December ...	23	8.90	226	3	15	5.34	136	5
Total	210	81.41	2068	...	209	156.87	3983	...

Greatest amount in 24 hours	3.34 ins. or 85 mm. ...	7.90 ins. or 200 mm.
Do. do. 48 do.	3 53 do. 90 mm. ...	10.02 254 mm.
Do. do. 72 do.	3 59 do. 91 mm. ...	11.17 283 mm.
Excessively rainy periods, more than 5 ins. having fallen in 72 hours	Nil	5 (Sept., Oct., Nov.)
No. of days when condition persisted ...	Nil	10
Periods of comparative drought, less than .02 ins. having fallen in 120 hours	12	7 (Jan.-Feb., Feb., Apr., June, July, July-Aug., Dec.).
(Jan.-Feb., Feb., Feb.-Mar., Apr., Apr.-May, June, Aug., Sept., Sept.-Oct., Oct., Nov.)		
No. of days when the condition occurred ...	37	7

* From Jan. 24 to Feb. 13 inclusive (21 days) there was only .02 ins. of rain.

Departmental Notices.

A list of plants which can be purchased at the Botanic Gardens, in Singapore and in Penang, can be had upon application. The same list appears at intervals in the Government Gazette.

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